TABLE II - 1 (Continued)

MAJOR AREA	TERRAIN REGION	RELIEF	DRAINAGE	VEGETATION	WATER SUPPLY
	(Lamo-Kaoe Block)	NW side.	small mountain streams; swamps on N side of Dodinga Bay.		
	Northern Halmahera (Volcanic Range)	High volcanic cones; rough hill country between; flat coastal plains on W.	Mountain streams; swamps at head of Djailolo Bay.	Rain forest in interior; clearings and second growth on coastal plains.	Wells and streams.
	Northern Halmahera (Galela Plain and Tiabo Valley)	Undulating to flat plain; narrow flat valley.	Tiabo River; swamps N of Galela, and in middle portion of Tiabo valley; Galela Lake.	Scattered patches of grassland, gardens, coconut groves and secondary forests on plain; Tiabo valley heavily forested.	Wells and streams.
	Northern Halmahera (NW Mountain Ridge)	Narrow, steep mountain range; narrow, discontinuous coastal plains.	Small mountain streams.	Rain forest; small clearings along coast.	Wells and streams.
	Morotai Island	Rugged interior; widest lowlands along SW coast.	Small mountain streams.	Rain forest; scattered clearings, gardens and second growth.	Wells and streams.
	Western Volcanic Islands	High volcanic cones; narrow coastal plains; fairly gentle, undissected lower slopes.	No permanent streams; small swamps on coastal strips.	Barren mountain tops; brush and forest farther down; gardens and plantations on lower slopes.	Wells and springs.
	Batjan Islands (Kasiroeta Island)	Rough hilly terrain; lowland in S.	Small streams, few have permanent flow; swamps at W end of S lowland.	Rain forest; small plantations and clearings along coast.	Wells and springs.
	Batjan Islands (Batjan Island)	Four mountainous peninsulas, separated by low, flat corridors.	Small streams; swamps east of Laboeha and along Sambaki Strait.	Rain forest; plantations in Laboeha area; scattered clearings and second growth.	Wells and springs.
	Batjan Islands (Obit Island)	Hilly interior; narrow coastal flats on W and S.	No permanent streams.	Coconuts along coast; rain forest in interior.	Wells and springs.
	Batjan Islands (Mandioli Island)	Hilly; narrow coastal plain.	No permanent streams; swampy on S coast.	Coconuts along coast; rain forest in interior.	Wells and springs.
Mindanao	Southern Mountains	Mountainous; Koranadal corridor NW of Sarangani Bay.	Short mountain streams.	Rain forest; grasslands at head of Sarangani Bay and in Koronadal Valley.	Wells, cisterns, and streams.
	Central Mountains	Mountainous; pass between Digos and upper Cotabato Basin.	Swift mountain streams.	Rain forest, moss forest; lower slopes cultivated in south.	Streams and springs.
	Davao Lowlands	Flat to rolling.	Small rivers; swamps at mouths of streams and at head of Davao Gulf.	Coconuts along the coast; extensive abaca plantations; some forest.	Wells, cisterns, and streams.
	Eastern Mindanao	Mountainous; isolated coastal plains at heads of bays; rough, hilly peninsulas.	Mountain streams; no large rivers; some swampy areas on coastal plains.	Dense rain forest; scattered clearings on coastal plains.	Wells and streams.
	Agusan Basin	Broad, flat lowland.	Agusan River system; extensive marshes and swamps.	Mostly dense rain forest; scattered clearings along the lower courses of the river.	Wells, cisterns, and streams.
	Bukidnon Uplands	Broad, sweeping slopes, deeply entrenched in the N; included volcanic mountain areas; many level upland areas.	Rapid streams; not navigable; those in north in canyon-like valleys.	Mountain areas in rain forest or moss forest; wide areas of grassland; patchy forest in extreme S.	Wells, cisterns, and springs.

TABLE II - 1 (Continued)

MAJOR AREA	TERRAIN REGION	RELIEF	DRAINAGE	VEGETATION	WATER SUPPLY
	Lanao Uplands	Diverse terrain; mountains, plateaus, coastal plains, and rolling country; latter dominant.	No large rivers, but some may be obstacles after heavy rains; swamps at head of Iligan Bay.	Much open grassland; scattered cultivation N of Lake Lanao; dense forest E of lake.	Wells, cisterns, and streams.
	Western Mindanao	Mostly mountainous; some hilly country; widest plains on extreme N and S.	Sibuguey River; small, mountain streams; much swamp on coastal plains at mouths of streams.	Rain forest; scattered grass lands on Zamboanga Peninsula; coastal plains on N and S cultivated.	Wells, cisterns, and streams.
	Cotabato Basin	Flat basin bordered on N by low terraces, steep edge on SW; some isolated flat-topped hills.	Mindanao River system; extensive marshy areas in central portion.	Rice cultivation in lower valley; marsh grasses, open grassland, and secondary forest in rest of basin.	Wells, cisterns, and streams.
Sulu Archipelago	Basilan Island	Hilly to mountainous interior; widest lowland on N.	Small streams; swamps along many coastal stretches.	Rain forest; N plain cultivated; some plantations along the coast.	Wells, cisterns or springs.
	Jolo Island	Volcanic hills and peaks separated by wide sweeping slopes; most rugged on W.	Few streams; swamps along low sheltered coasts.	Mostly under cultivation or second growth; forests on peaks.	Wells, springs or cisterns.
	Tawitawi Island	Rough, hilly interior; a few coastal flats.	No permanent streams; a few coastal swamps.	Mostly rain forest; grass and clearings at SW end.	Inadequate supply. Shallow wells and cisterns.
Borneo	British North Borneo	Mountainous interior especially toward W; narrow coastal plains on W interrupted by hills; broad river flood plains on E coast.	Short mountain streams on W coast, except Padas R.; large rivers flow to E coast; extensive swamps SE of Sandakan, and at river mouths.	Rain forest; some grassy clearings, second growth, and cultivation along W coast; swamp forests along E coast, some moss forest.	Wells, springs, and streams.
	Dutch East Borneo	Rough hill land; some interior basins; broad river flood plains; isolated ridges and hills; mountains on W border.	Large river systems: Sembakoeng, Sesajap, Kajan, Beraoe, and Mahakam.	Rain forest; scattered cultivation and secondary forest along streams.	Wells, springs, and streams.
Celebes	Minahasa-Bolaäng-Mongondow	High volcanic cones; plateaus; narrow coastal plains; several passes.	Mountain streams; Lake Tondano.	Forested summits; much cleared and cultivated land (rice, corn), and secondary growth.	Wells, springs, and streams.
	Northern Peninsula	Central mountain range; narrow coastal plains; only one gap in range (Gorontalo-Koeandang).	Mountain streams.	Mountains covered with rain forest; lower slopes scattered second growth and clearings; coastal plain cultivated land, second growth, and swamp forest.	Wells, springs, and streams.

26. *Critical Areas*

Since the land areas within the region under consideration are so scattered, no one area can be termed critical. There are, however, 4 areas each, located on one of the major islands of the region, that have considerable strategic importance. These include the Kaoe Bay area of Halmahera, the Bukidnon Uplands of Mindanao, the Island of Tarakan off the east coast of Borneo, and the Minahasa Region of Celebes. The strategic importance of the first two and the last is the result of terrain and position. The third, Tarakan, is important only because of its oil, which can be used as fuel oil directly, without being refined.

A. Kaoe Bay Area, Halmahera.

This area is strategically located about midway between the southern portion of the Philippines and the Vogelkop, or westernmost, area of New Guinea. Kaoe Bay is a large sheltered anchorage that will accommodate an entire fleet. There are low, flat lands in the vicinity, where the Japanese have several air fields in use or under construction. The rugged peninsulas on either side of the bay provide good defensive positions.

B. Bukidnon Uplands, Mindanao.

Despite the fact that this region is located in the central portion of the island, it is the natural fortress of Mindanao. Its innumerable airfields and potential airfield sites, its natural defensive phase lines, and its road connections to both the northern and southern coastal areas, make it the logical center of defense by ground and air forces.

C. Tarakan, Borneo. (PLANS 40 and 46).

This island is located just off the swampy delta area at the mouth of the Sesajap River in eastern Borneo. Its importance is due to its oil fields. It is not an easy area to attack, as the island is bordered on nearly all sides by dense mangrove swamps, and contains a hilly, heavily-wooded central core.

D. Minahasa Region, Celebes. (PLANS 48, 54, 55, and 62).

There are two main objectives for military operations in this area. These are the harbor of Manado, and the airbases near Tondano Lake. Other factors which contribute to the strategic importance of the Minahasa Region are the general suitability of the terrain for military operations, the relatively good network of roads, and the available local labor supply.

27. *Routes to Critical Areas*

The chief routes to critical areas are shown in FIGURE II - 45.

A. Kaoe Bay Area, Halmahera.

At the present time, there are no motor roads leading to the Kaoe Bay Area from other parts of the island. The only routes, with the exception of the bridle track across the Dodinga Isthmus, are along native footpaths. There are many of these, especially from the west coast, but few of them have potentialities as routes for possible motor supply roads. From an analysis of topographical maps, there appear to be only 4 routes which have terrain suitable for such roads. These are in order from north to south (FIGURE II - 45).

1. Loloda Bay-Galela-Tobelo-Mawea-Kaoe. Total distance about 125 miles.
2. Iboe-Kaoe valley. 63 miles.
3. Dodinga Isthmus bridle path. 2½ miles.
4. Kobe-Ekor (Weda Bay-Kaoe Bay). 35 miles.

The principal disadvantages of the routes in their present condition are the dense forests growing on interior hill country, the occasional swampy areas, and the short steep grades that are found locally.

B. Bukidnon Uplands, Mindanao.

This strategically important area in the central portion of Mindanao has immediate approaches only from the north and south, but there are several points along the periphery of the island from which good routes lead toward these two entrances. These critical coastal points include:

1. The bays along the east coast of Mindanao, from Lanuza Bay on the south, to Surigao on the north.
2. The bays along the north coast of the island (excluding Panguil Bay, and the coast farther west).
3. Pagadian Bay (the head of Illana Bay), and the east side of Illana Bay.
4. The head of Sarangani Bay.
5. The northwest side of Davao Gulf.

The routes from these coastal points toward the Bukidnon Uplands are utilized by good motor roads, but they are more than just roads, since there is open, low terrain suitable for deployment most of the way along each route. The most logical defense lines are found where these routes cross hilly terrain (south of Mount Apo; skirting the rocky peninsulas of the north coast; south of Lake Lanao; and climbing the northern escarpment of the Bukidnon Uplands, or where they cross the 2 large rivers on the island (the Agusan and Mindanao-Pulangi). Although these are the only routes suitable for motor transport or for large numbers of troops, there are a number of foot or pack trails through forested, mountain country, that lead toward the strategic area both from the east and the west.

C. Borneo.

There is no approach to Tarakan other than by sea; furthermore, the mainland opposite the island consists of low, swampy, delta country, covered with mangroves and other swamp vegetation, and without any access to the rest of the island other than by boat along the coast, or up the rivers to inland trail connections.

On the northwest coast of Borneo, a possible strategic route exists including the coastal road leading north and south from Jesselton, provided connections were made with Brunei and the oil fields of Sarawak. Unless some route could be found circumventing the swamps on the east side of Brunei Bay, this route would have only local significance, as for example, for use in possible operations against the air base at Jesselton, or the one reported at Kudat. The route is not a good one, since there are numerous good defensive positions along it, such as narrow defiles and river crossings.

D. Northern Celebes.

The Minahasa Region and the most critical points within it (the Lake Tondano district and the port of Manado), are accessible from the following points:

1. Along the macadamized road from Lombagin to Amoerang;
2. From either end of the Manado-Kema road;
3. From either end of the Amoerang-Belang road; and
4. From the northeastern tip (Likoepang).

Access to the interior is restricted by steep slopes to the routes leading inland from the points mentioned above, but once the plateau is reached, there is a fairly good network of roads, and the terrain would permit deployment off the roads in many places. The Gorontalo-Koeandang route, a considerable distance west of the Minahasa Region, has some strategic significance because it bisects the northern peninsula. A possible potential route also exists from Gorontalo, via the Bone Valley, eastward toward the upper portion of the Ongkag-Doemoga basin, from which a motor road leads to Minahasa, via Lombagin. A military road along this route was begun prior to the war, but was never completed. Much of it is through hilly to mountainous terrain.

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FIGURE II - 42
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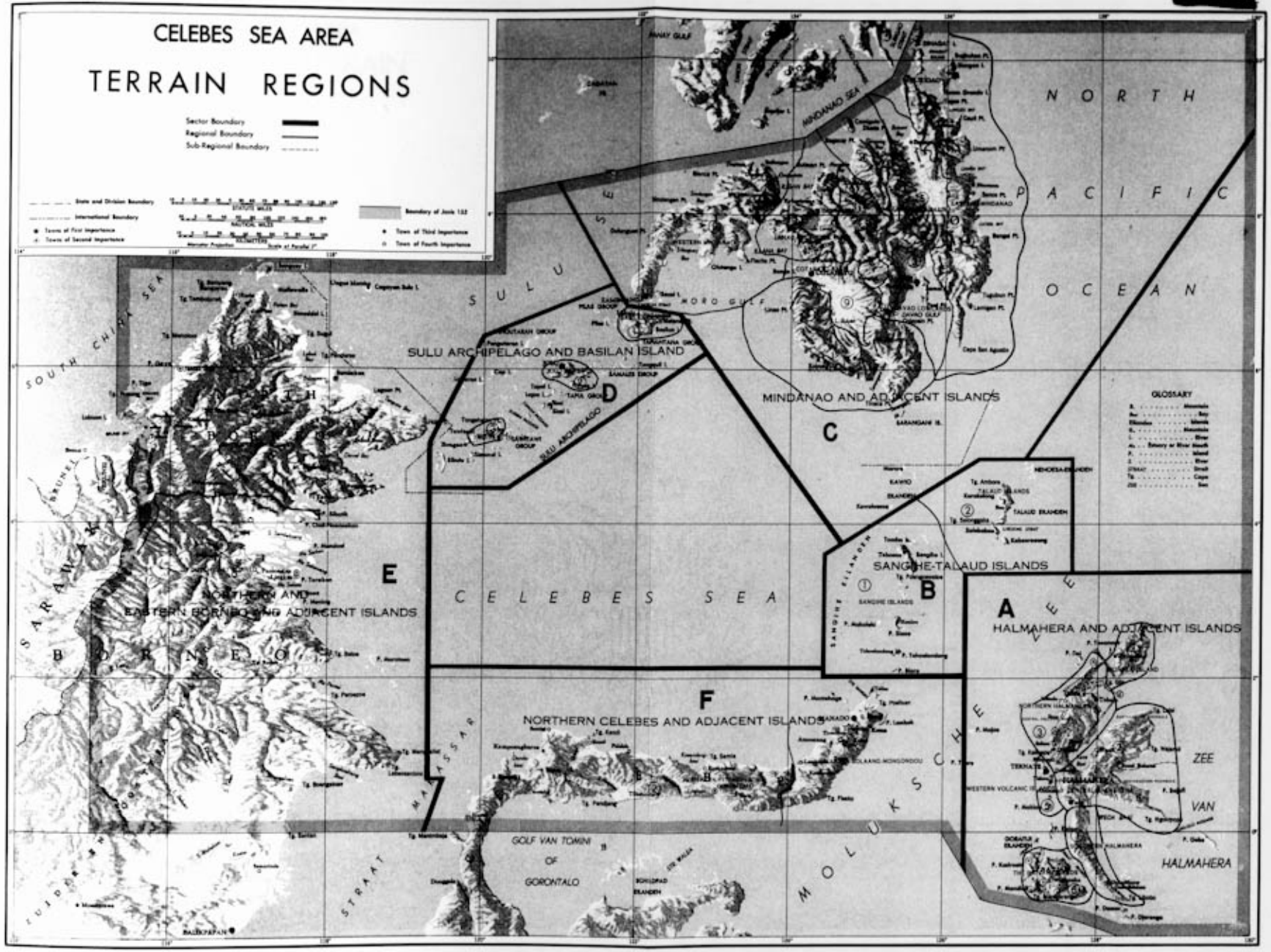

FIGURE II - 43
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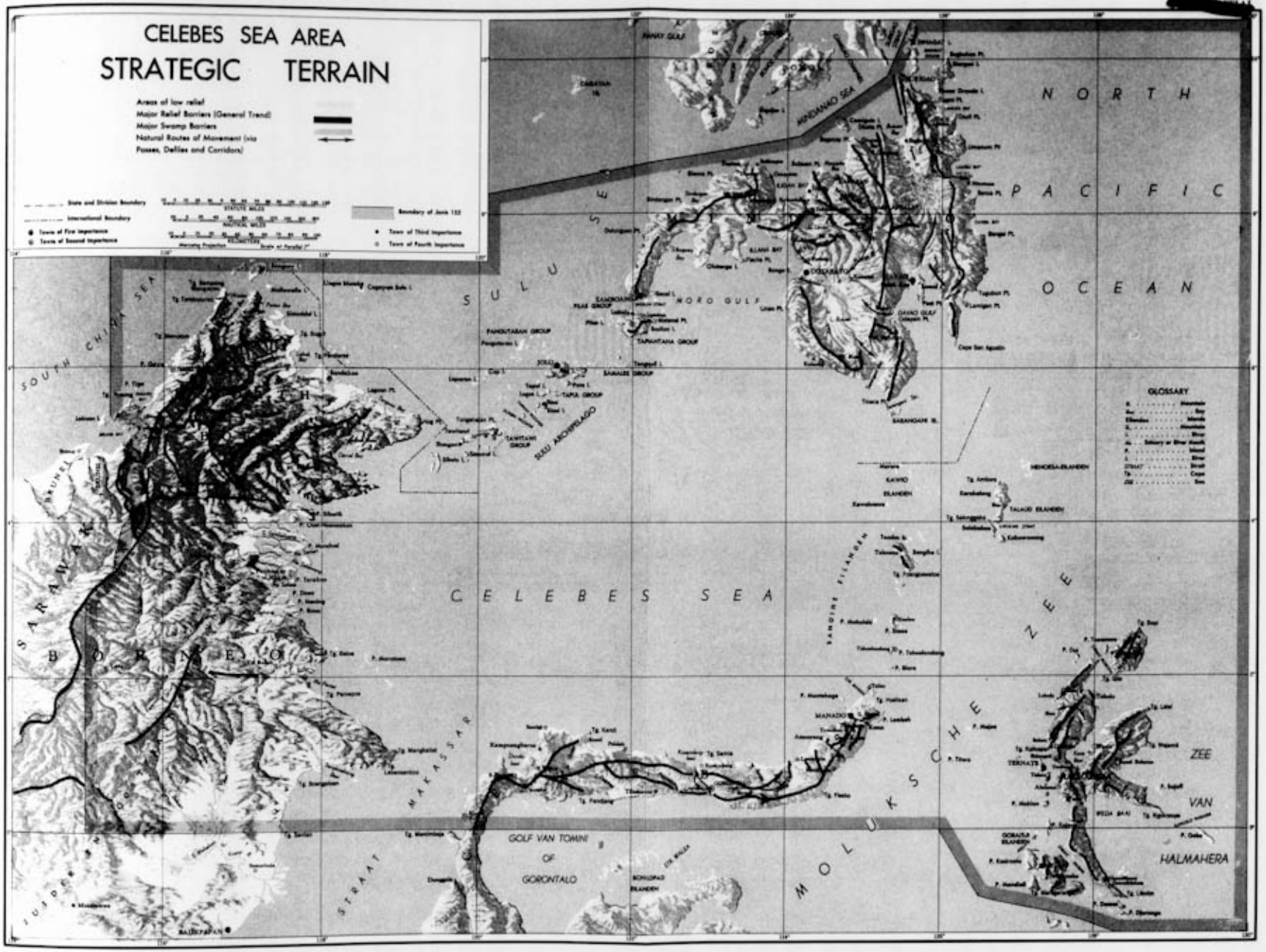

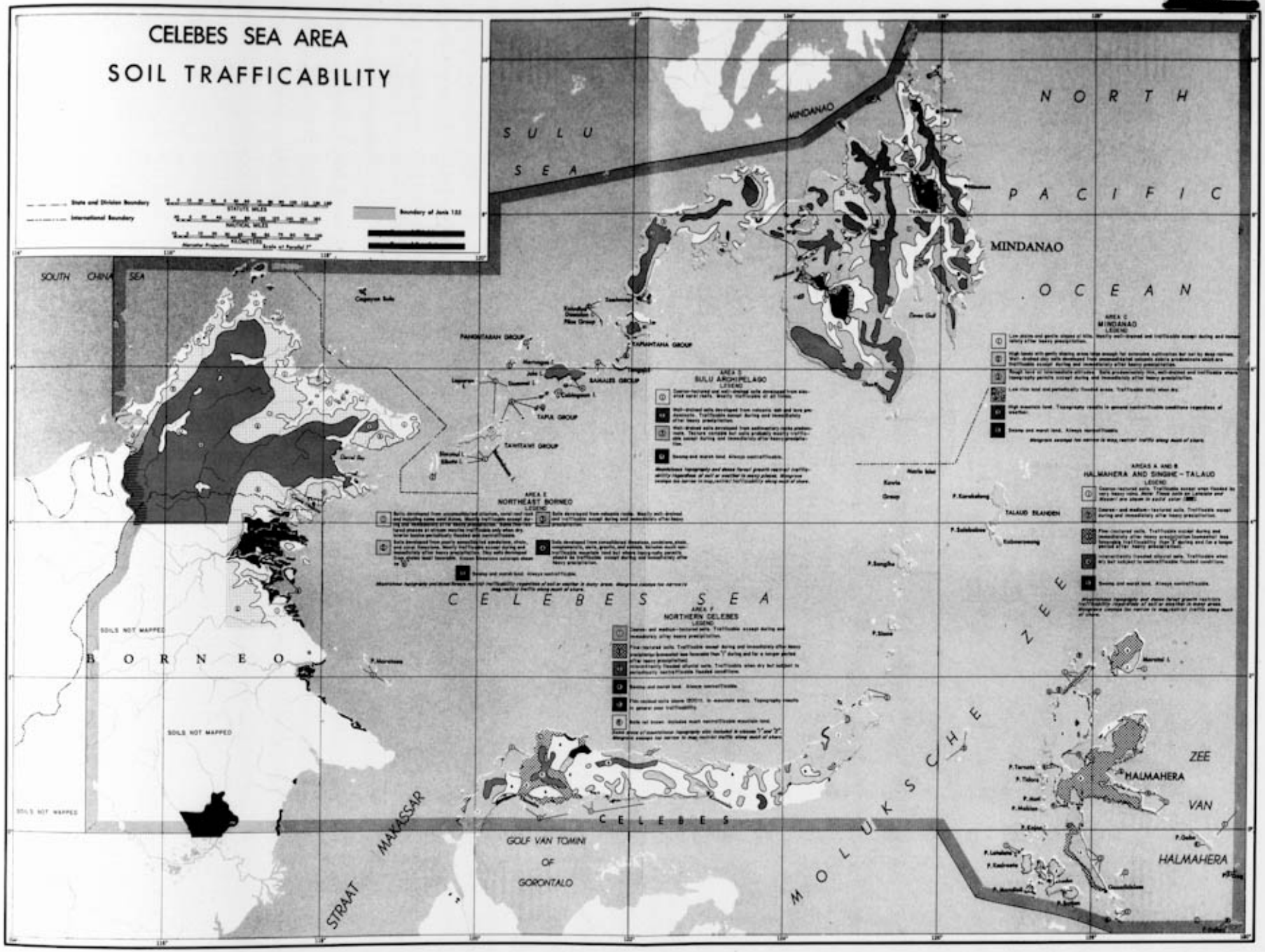
CELEBES SEA AREA
SOIL TRAFFICABILITY
State and Division Boundary
International Boundary
Boundary of Area 155
SULU SEA
MINDANAO SEA
NORTH PACIFIC OCEAN
MINDANAO
SOUTH CHINA SEA
PANGUTARAN GROUP
SANGALES GROUP
TAPUL GROUP
TAWITAWI GROUP
SULU ARCHIPELAGO
NORTHEAST BORNEO
NORTHERN CELEBES
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HALMAHERA AND SINGHE - TALAUD
TALAUD ISLANDEN
CELEBES SEA
BORNEO
SOILS NOT MAPPED
CELEBES
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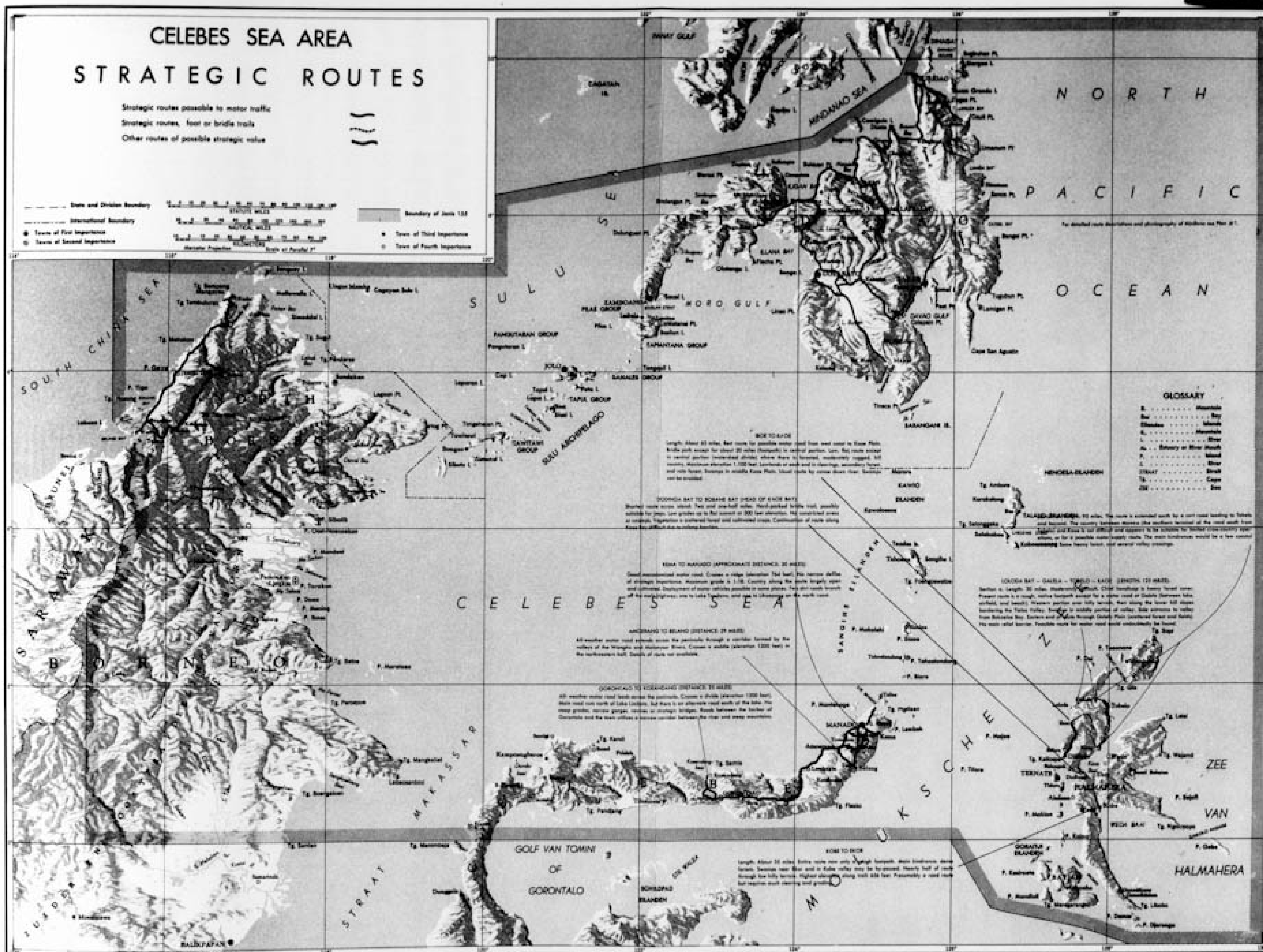
OF
GORONTALO
STRAAT MAKASSAR
MOLUKSCHE ZEE
HALMAHERA
VAN
HALMAHERA


CELEBES SEA AREA
STRATEGIC ROUTES
Strategic routes passable to motor traffic
Strategic routes, foot or bridle trails
Other routes of possible strategic value
Boundary of Janis 155
N O R T H
P A C I F I C
O C E A N
S U L U S E A
MINDANAO SEA
MORO GULF
SULU ARCHIPELAGO
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GOLF VAN TOMINI
OF
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CHAPTER III

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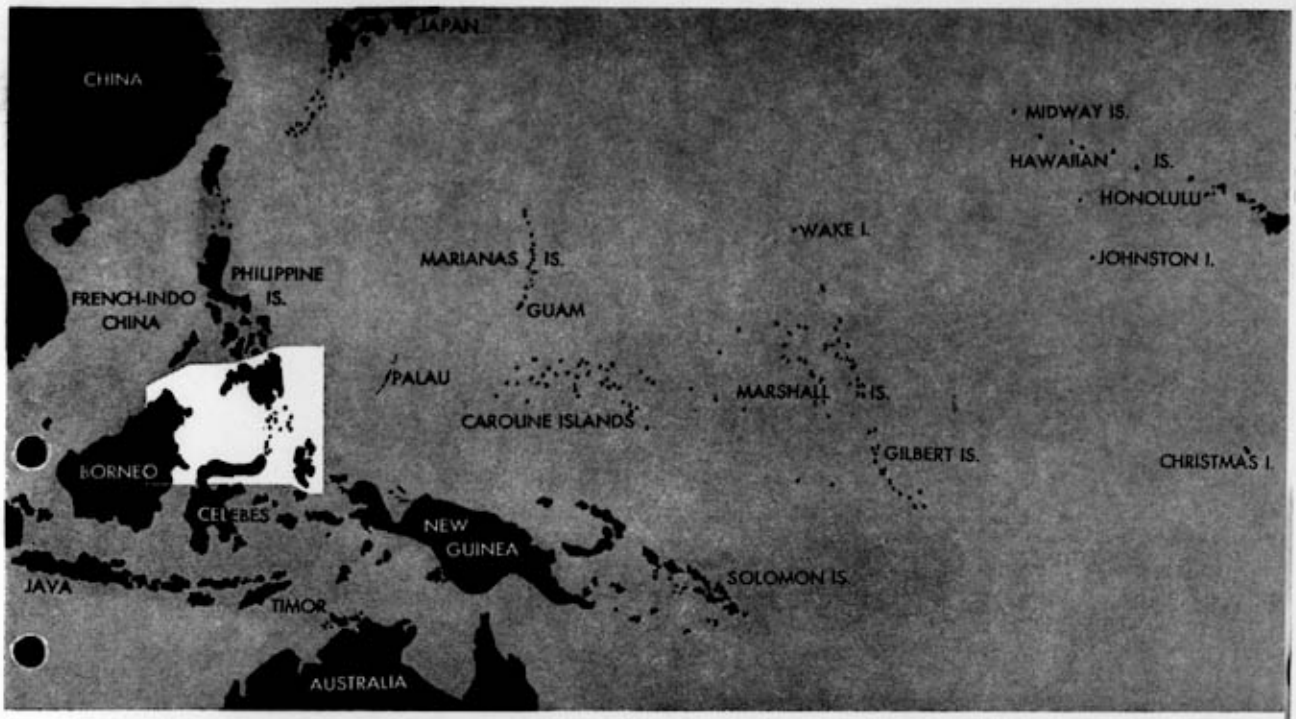

JOINT ARMY-NAVY INTELLIGENCE STUDY

OF

CELEBES SEA AREA

OCEANOGRAPHY

MAY 1944

List of Effective Pages, Chapter III

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Figure and Key (insert, reverse blank)	Original	Figure III-2
Figure and Key (insert, reverse blank)	Original	Figure III-3
Figure and Key (insert, reverse blank)	Original	Figure III-4
Figure and Key (insert, reverse blank)	Original	Figure III-5
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Figure (insert, reverse blank)	Original	Figure III-11
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Note: This chapter is based on material available in Washington, D. C., on 25 April 1944.

FIGURE III - 1
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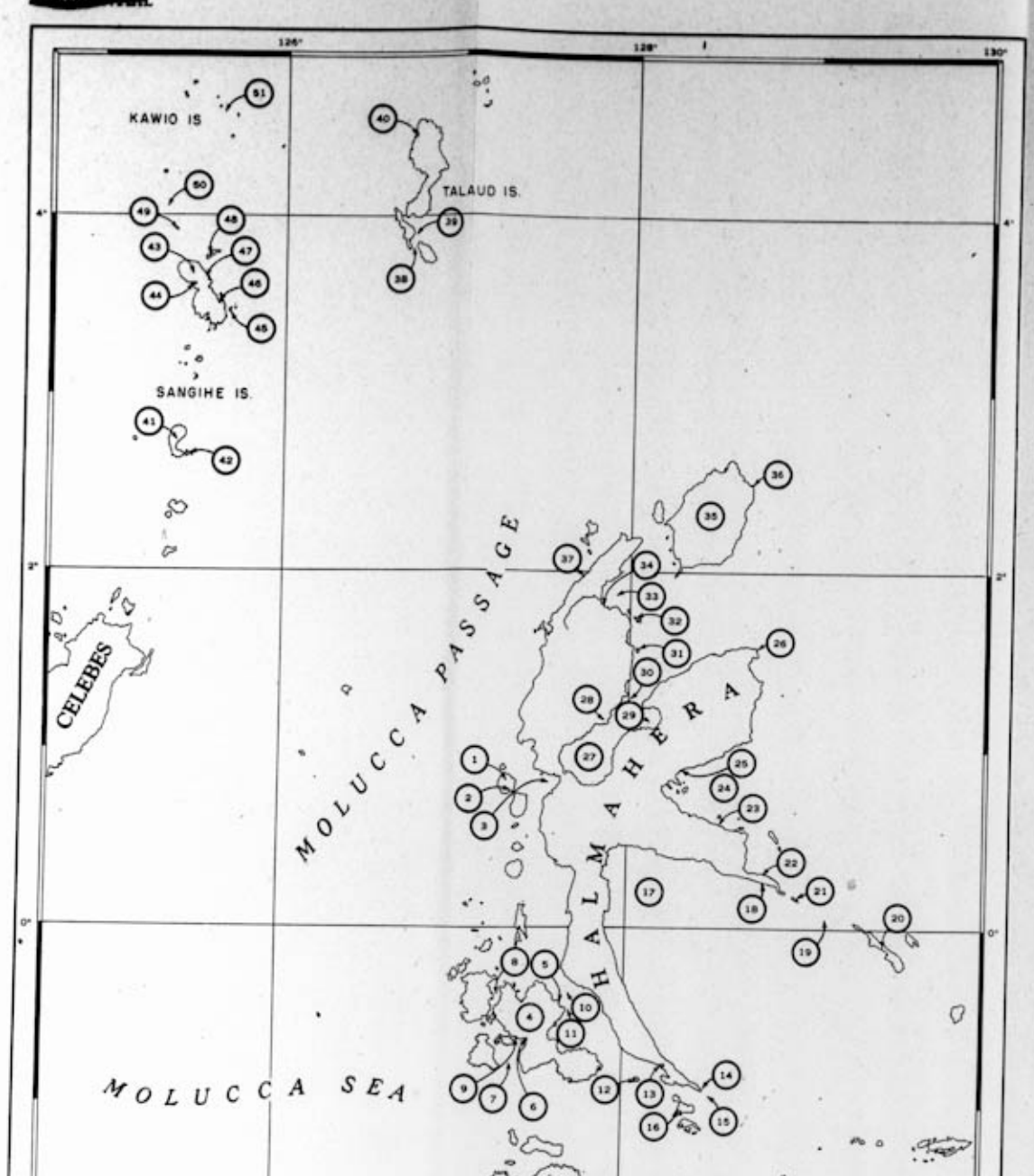

FIGURE III - 1.
Location of places mentioned in the text, Halmahera and adjacent islands.

Key to Figure III-1

1. Ternate I.
2. Ternate, Ternate Roads
3. Dodinga
4. Batjan I.
5. Waisabarang
6. Laboeha
7. Batjan Strait
8. Sambaki Strait
9. Lambak Bay
10. Patinti Strait
11. Koesoe Is.
12. Dowora Is.
13. Gape Bay
14. Libobo Point
15. Babi I.
16. Damar I.
17. Weda Bay
18. Gamsoengi
19. Djailolo Passage
20. Gebe I.
21. Moeor I.
22. Tepelea
23. Bitjoli
24. Boeli Bay
25. Boeli-serani
26. Lelai Point
27. Kaoe Bay
28. Kaoe
29. Waisile
30. Boebale I.
31. Miti I.
32. Tobelo Is.
33. Galela Bay
34. Galela Roads
35. Morotai I.
36. Gorango Point
37. Asimiro
38. Kaboeroeang Strait
39. Liroeng Road
40. Essang Bay
41. Siaoe I.
42. Pahepa I.
43. Sangihe I.
44. Tahoena
45 Beng-darat
46. Manaloe
47. Peta Bay
48. Toade Is.
49. Lipang I.
50. Louise Bank
51. Memanoek Bank

FIGURE III - 2
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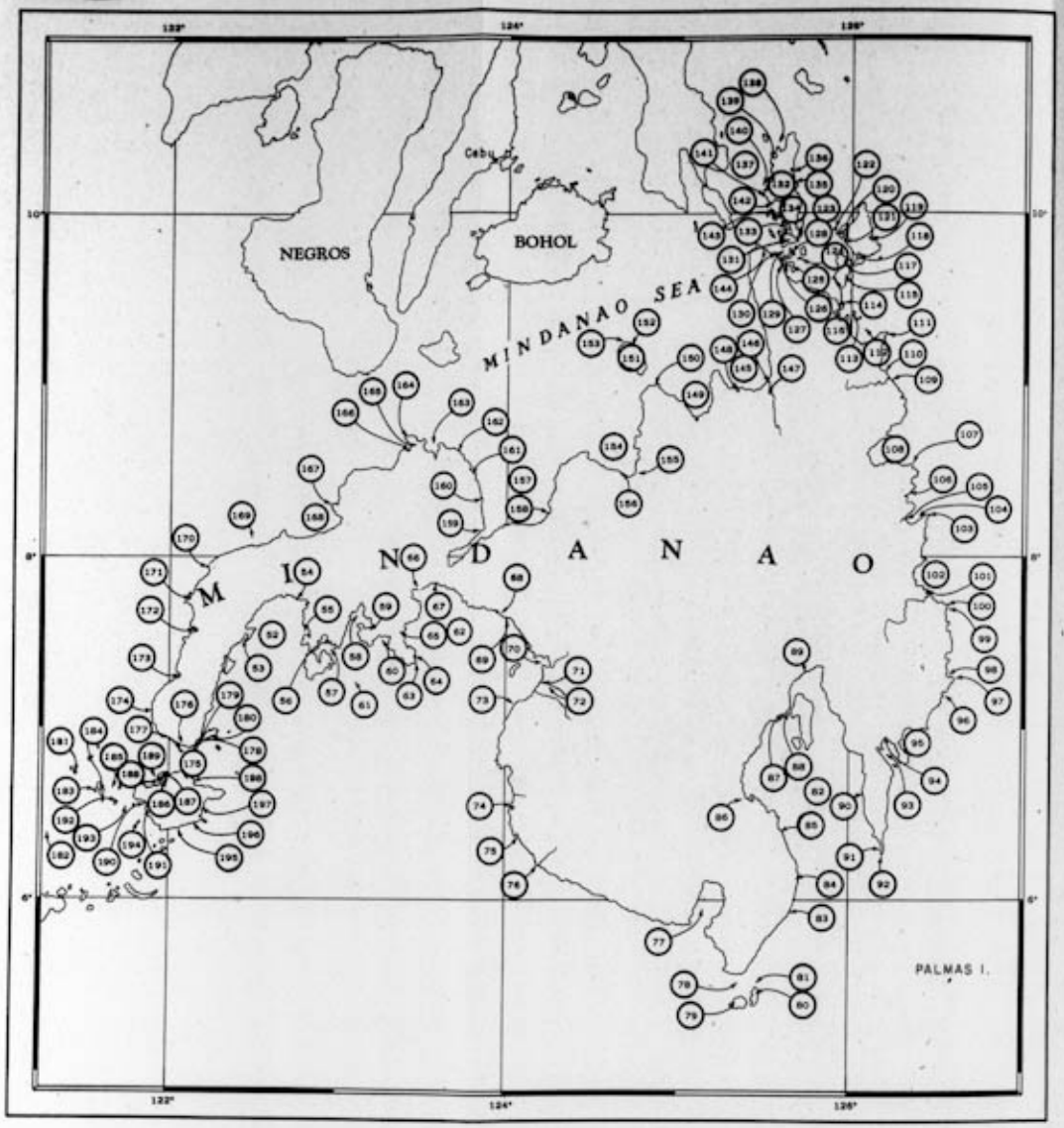

FIGURE III - 2.
Location of places mentioned in the text, Mindanao.

Key to Figure III-2

[redacted]
53. Port Banga
54. Ticsuan Point
55. Taba Bay
56. Naga-Naga
57. Port Sibulan
58. Dumanquilas Bay
59. Margosatubig
60. Maligay Bay
61. Liacum Bank
62. Illana Bay
63. Flecha Point
64. Limbug Cove
65. Port Sambulauan
66. Pagadian
67. Tucuran
68. Tuka Bay
69. Port Baras
70. Polloc Harbor
71. Mindanao River
72. Cotobato
73. Tapian Point
74. Port Lebak
75. Tuna Bay
76. Palimban Point
77. Sarangani Bay
78. Sarangani Strait
79. Balut I.
80. Sarangani I.
81. Olanivan I.
82. Davao Gulf
83. Banos Point
84. Calian Point
85. Malita
86. Bolton (Malalag)
87. Davao
88. Pakiputan Strait
89. Tagum River
90. Sigaboy I.
91. Lavigan Anchorage
92. Cape San Agustin
93. Pujada Bay
94. Mati
95. Mayo Bay
96. Casauman Point
97. Pusan Point
98. Caraga Bay
99. Bagoso I.
100. Bangai Point
101. Cateel River
102. Cateel Bay
103. Sanco Point
104. Bislig Bay
105. Bislig River
106. Hinatuan River
107. Bakulin Point
108. Lianga Bay
109. Tago River
110. Tandag
111. Cauit Point
112. Lanuza Bay
113. Buenavista
114. Tugas Point
115. Bucas Grande I.
116. Sohutan Bay
117. Port Barruecas
118. San Miguel
119. Port Pillar
120. Numancia
121. Pamay Bay
122. Tayanan
123. Dinagat Sound
124. Cuyomongan
125. Masapelid I.
126. Masapelid Passage
127. Taganaan Estero
128. Bayagnan I.
129. Rasa I.
130. Lapinig I.
131. Nonoc Island
132. Dinagat I.
133. Awasan Bay
134. Port Gabo
135. Gaas Bay
136. Malinao Inlet
137. Surigao Strait
138. Kayasas Islets
139. Esconchada Point
140. Kanihaan I.
141. Puerto Princesa
142. Melgar
143. Dinagat
144. Surigao
145. Butuan Bay
146. Agusan River
147. Butuan
148. Nasipit Harbar
149. Gingoog Bay
150. Canausyor Anchorage
151. Camiguin I.
152. Mambajao
153. Medano Islet
154. Macajalar Bay
155. Bugo
156. Macabalan Point
157. Iligan Bay
158. Iligan
159. Port Misamis
160. Jimenez
161. Oroquieta
162. Plaridel
163. Murcielagos Bay
164. Tagolo Point
165. Dapitan
166. Port Puluan
167. Lanboyan Point
168. Sindangan Bay
169. Murcielagos Is.
170. Coronado Point
171. Puerto Santa Maria
172. Panabutan Bay
173. Sibuco Bay
174. Batorampon Point
175. Basilan Strait
176. Zamboanga
177. Great Santa Cruz I.
178. Tictsuan Channel
179. Masinloc anchorage
180. Landang
181. Dassalan
182. Pabunuan Shoal
183. Manangal I.
184. Pilas I.
185. Pilas Channel
186. Isabela Channel
187. Malamaui I.
188. Moro I.
189. Pamelukan Bank
190. Maluso Bay
191. Port Holland
192. Mataja I.
193. Sicagot I.
194. Tamuk I.
195. Bihintinusa Channel
196. Amaloy
197. Bohelebong
198. Balas

FIGURE III - 3
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FIGURE III - 3.
Location of places mentioned in the text, Sulu Archipelago.

Key to Figure III-3

181. Dassalan
182. Pabunuan Shoal
183. Manangal I.
184. Pilas I.
185. Pilas Channel
186. Isabela Channel
187. Malamaui I.
188. Moro I.
189. Pamelukan Bank
190. Maluso Bay
191. Port Holland
192. Manajo I.
193. Sicagot I.
194. Tamuk I.
195. Bihintinusa Channel
199. Tapiantana Channel
200. Saluping I.
201. Tapiantana I.
202. Linawan I.
203. Bubuan I.
204. Tonquil I.
205. Mamad I.
206. Bucutua
207. Bulan I.
208. Gumila Reef
209. Simisa I.
210. Capual I.
211. Bulicutin I.
212. Patotol Bay
213. Tulayan I.
214. Jolo Harbor
215. Sulade I.
216. Maimbung Bay
217. Damocan I.
218. Pata I.
219. Lugus I.
220. Tapul I.
221. Laminusa I.
222. Sisai I.
223. Siasi
224. Lapac I.
225. Tapaan I.
226. Favorite Bank
227. Pangutaran Reef
228. Pangutaran I.
229. Pangutaran Passage
230. Sail Rock
231. Cap I.
232. Deastobato I.
233. Laparan I.
234. Doc Can I.
235. Pearl Bank
236. Dammai I.
237. Lahatlahat I.
238. Babas Channel
239. Tumbagaan I.
240. Sugbai I.
241. Cacasan I.
242. Midchannel Bank
243. Sugbai Passage
244. Tapaan Passage
245. Kinapusan I.
246. Tagao I.
247. Pasegan Guimba
248. Tandungan I.
249. Tandungan Channel
250. Bakeke I.
251. Baturapac I.
252. Calsitan Channel
253. Sipungut Channel
254. Tandubas I.
255. Secubun I.
256. Basang Dakula
257. Gallo Malo Channel
258. Tawitawi Bay
259. Banarsan I.
260. Balimbing Channel
261. Bilatan I.
262. Balaeyro Channel
263. Simunul Channel
264. Manuk Manka I.
265. Simunul I.
266. Laa I.
267. Batu Batu Bay
268. Luuk Sula Bay
269. Port Bongao
270. Bongao I.
271. Tampat Point
272. Sanga Sanga I.
273. Manalik Channel
274. Bato Bato I.
275. Bakbau Dakula I.
276. Luuk Saul
277. Tarasan Pass
278. Sibutu Passage
279. Sibutu I.
280. Tumindao Channel
281. Tumindao I.
282. North Lagoon
283. Meridan Channel
284. Purdie Patches
285. Bajapa
286. Riddells Reef
287. Frances Reef

FIGURE III - 4
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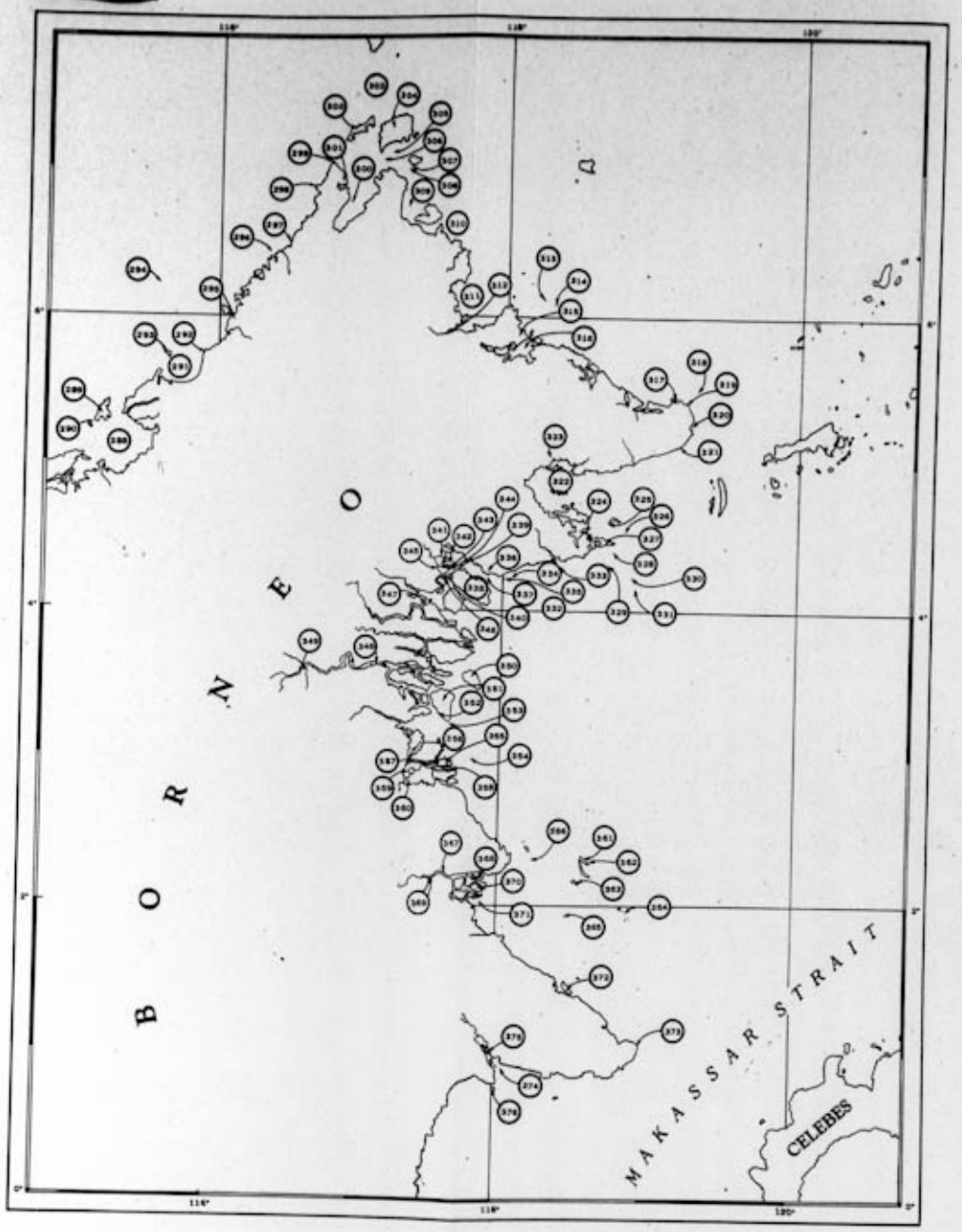

FIGURE III - 4.
Location of places mentioned in the text, Northeast Borneo.

Key to Figure III-4

288. Brunei Bay
289. Labuan I.
290. Keraman Channel
291. Kimanis Bay
292. Papar River
293. Tiga Island
294. Mengalum I.
295. Gaya Bay and Jesselton Harbor
296. Usukan I.
297. Makarang Point
298. Tambaluran Point
299. Sampanmangio Point
300. Marudu Bay
301. Kudat, Marudu Bay
302. Balambangan I.
303. Balabec Strait
304. Banguey I.
305. Banguey South Channel
306. Ten Foot Rock
307. Mallawalle Channel
308. Passage Reef
309. Paitan Bay
310. Marches Bay
311. Labuk Bay
312. Labuk River
313. Taganak Patches
314. Taganak Island
315. Sandakan
316. Sandakan Harbor
317. Tambisan
318. Sentry Bank
319. Unsang Point
320. Dent Haven
321. Labian Point
322. Darvel Bay
323. Lahad Datu
324. Semporna I.
325. Tatagan I.
326. Baturna Reef
327. Bum Bum I.
328. Beaufort Reef
329. Ligitan Channel
330. Ligitan Group
331. Ligitan I.
332. Sibuko Bay
333. Friedrich Haven
334. English Spit
335. Tinagat Rock
336. Tawau
337. Cowie Harbor
338. Sebatik I.
339. Grassy Point
340. Coal Mine Reach
341. Kalabakang River
342. Pilot Bank
343. Adolphy Point
344. Simandalan River
345. Merlin Channel
346. Serudong River
347. Siboekoe River
348. Sesajab River
349. Malinau
350. Boenjoe or Tanahmerah I.
351. Tarakan I.
352. Tarakan Anchorage
353. Menoeloen
354. Makapan Channel
355. Mening
356. Temenggah River
357. Boeloengan River
358. Biwan Mouth
359. Belugan River
360. Selor Point
361. Maratoea Reef
362. Bahaba Point
363. Kakaban I.
364. Moeras Reef
365. Malalungan Reef
366. Derawan Island
367. Bersoe River
368. Kasai Mouth
369. Haji Bank
370. Goentoeng I.
371. Pantai Mouth
372. Tandjoeng-boesajaboesaja I.
373. Mangkalihat Point
374. Sangkoelirang River
375. Sangkoelirang
376. Miang-besar

FIGURE III - 5
JANIS 155

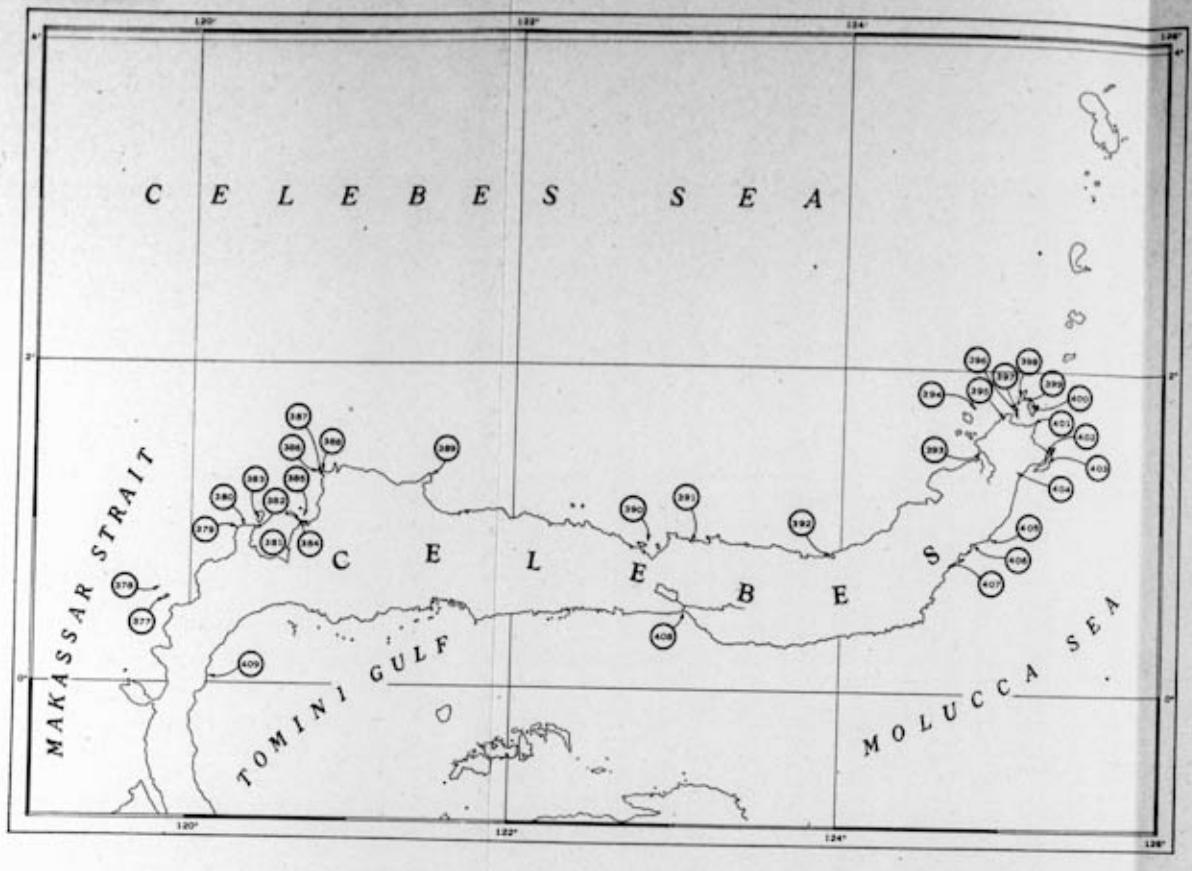

FIGURE III - 5.
Location of places mentioned in the text, North Celebes.

Key to Figure III-5

377. Mapoeti Is.
378. Toegoean I.
379. Lingian I.
380. Dondo Point
381. Dondo Bay
382. Babandji Point
383. Simatang I.
384. Paligisan Point
385. Tolitoli-baai
386. Silando Is.
387. Kapas Strait
388. Stroomen-kaap
389. Kandi Point
390. Koeandang-baai
391. Himana Bay
392. Bolaängoeki Bay
393. Manado Bay
394. Naeng-besar
395. Kora Kora Bay
396. Bangka Strait
397. Gangga I.
398. Talise I.
399. Kinabahoetan I.
400. Bangka I.
401. Poeisan Point
402. Lembeh Strait
403. Lembeh I.
404. Kema Road
405. Bentenan I.
406. Belang Road
407. Kotaboena Road
408. Gorontalo River
409. Maninili

OCEANOGRAPHY

30. General Description

A. Tides.

The tides in this area are complex, varying from semidiurnal tides with some inequality between morning and afternoon tides to those that become entirely diurnal (one tide a day) for certain portions of each month. At some places, the average range at the time of tropic tides exceeds 9 feet.

B. General circulation.

The greatest flow of water into the Celebes Sea is southwesterly through the passage between the southeast coast of Mindanao and the Talaud Islands. Within the Celebes Sea, the water circulates in a counterclockwise direction, and most of it leaves the area through the northeastern part of Molucca Passage. Some water also enters from the Sulu Sea through Sibutu Passage except during the spring and summer, when the current is reversed. Also, some water leaves the area through Makassar Strait.

Strong tidal currents are to be expected in numerous localities within the area.

C. Sea and swell.

High sea and swell are infrequent in the areas covered by this report. The 4 areas differ slightly in the monthly distribution of the amounts of sea but, in general, the sea is least disturbed during April, May, and June and is roughest during December and January. Sea and swell are predominantly from the northeast from November through April and from the south or southwest during the rest of the year.

D. Sea-water characteristics.

Water temperature at the surface ranges between extremes of 76° and 88° F., and at 300 feet, between 60° and 84° F. Temperature gradients are not common just below the surface, but there is an average difference of 9.4° F., with a maximum of 28° F., between the surface and 300 feet.

Extreme salinity values of 30.91 and 36.20 parts per thousand have been recorded at the surface; the average surface salinity is 34.03 parts per thousand. Lower values are to be expected close to shore owing to fresh-water run-off. At a depth of 300 feet, the salinity ranges from 33.20 to 37.74 parts per thousand, with an average of 34.62 parts per thousand.

Density layers are frequently found below 100 feet. Only rarely will submarines be able to balance on these layers, and ballast changes of 2,000 to 19,000 pounds will be required.

Echo-ranging conditions are usually *fair* throughout the year, except when the background-noise level is high. Assured echo ranges of 1,500 to 2,000 yards may be expected away from the islands. Screw noises have been recorded at a maximum distance of 10,000 yards, and pinging at a distance of 12,000 yards.

Away from land the water is relatively clear and blue.

E. Bottom sediments.

The shelves surrounding the islands in the Celebes area are narrow. For the most part, the shallow-water bottoms consist of alternating patches of *sand* and *coral* and some *stone*. In large bays and off the mouths of the rivers of Mindanao and Borneo, the bottom is generally *mud*. *Mud* may also be expected in the more protected bays on the smaller islands.

31. Tides and Currents

A. Tides.

(1) Tidal differences and constants.

The data shown in TABLE III - 7 give the characteristics of the tides and permit tide predictions for the places listed by applying the tidal differences to daily predictions for the appropriate reference stations (TABLE III - 8).

(*a*) *Time differences.* These differences are applicable to both high and low water, unless otherwise indicated, and will give predictions for all places in the kind of time indicated in TABLE III - 7. It should be noted that standard time of the meridian indicated is used and not "summer time" or daylight-saving time. A plus sign means that the tide is later than at the reference station and the difference should be added; a minus sign means the tide is earlier and the difference subtracted.

(*b*) *Height differences.* The height of the tide, referred to the datum of charts, is obtained by means of a ratio together with a correction for datum. Multiply the heights of high water and low water at the reference station by the ratio. The correction for datum must then be applied to the resulting heights by adding or subtracting, as indicated.

(*c*) *Ranges.* Since the type of tide varies throughout this area, several different ranges are given. The range of tide is the difference in height between consecutive high and low waters. *Mean range* is the average range over a considerable period of time. *Spring range* is the average of the large ranges that occur fortnightly near the time of new and full moons. *Diurnal range* is the range between the higher high and lower low water of a day or between the high and low if there is only one tide during the day. *Mean diurnal range* is the average of all the diurnal ranges over a considerable period of time. *Tropic range* is the average of the large diurnal ranges that occur fortnightly when the moon is near its maximum declination.

(*d*) *Levels.* Mean sea level (MSL) above chart datum is given in the last column. The approximate average levels of high and low waters at the times of the various tides, such as mean, spring, or tropic, can be obtained from mean sea level by adding and subtracting one-half the corresponding range.

(*e*) *Example.* To find the times and heights of the high and low waters for Plaridel (162)*, Mindanao, on 13 December 1944, and to draw a curve which will show the height at any time during the day, obtain predictions for Plaridel (162) in 120° E meridian time by applying a time difference, a height ratio, and a correction for datum (TABLE III - 7) to daily predictions for Cebu (TABLE III - 8g). The necessary predictions for Cebu, the tidal differences to be applied, and the result-

*Numbers in parentheses refer to locations on FIGURES III - 1 to III - 5.

ing predictions for Plaridel (162) for that date are shown below.

	High Water		Low Water		High Water		Low Water	
	h. m.	ft.	h. m.	ft.	h. m.	ft.	h. m.	ft.
Cebu predictions for 13 December 1944	10 13	2.7	4 24	0.4	21 47	4.5	15 30	1.2
Time difference and height ratio	—0 25	0.8	—0 25	0.8	—0 25	0.8	—0 25	0.8
		2.2		0.3		3.6		1.0
Datum correction		+0.1		+0.1		+0.1		+0.1
Resulting predictions for Plaridel (162), 13 December 1944	9 48	2.3	3 59	0.4	21 22	3.7	15 05	1.1

The resulting times and heights are plotted on cross-section paper (FIGURE III - 6); these points are then connected by a curve similar in shape to the typical curve (semidiurnal) for places referred to Cebu (FIGURE III - 12).

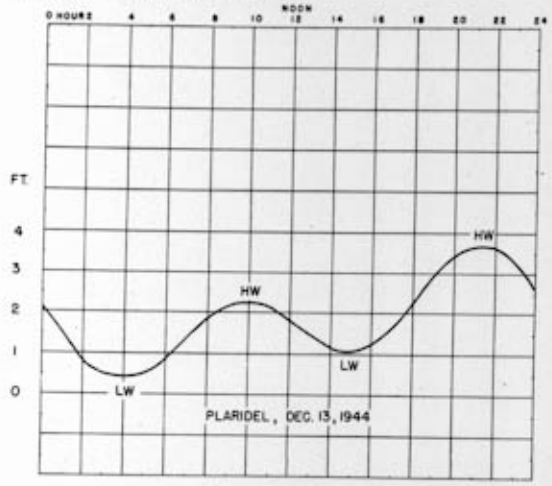

FIGURE III - 6.
Example of tide curve for Plaridel, constructed by use of table of tidal differences and constants (TABLE III - 7) and typical tide curves (FIGURE III - 12).

From this tide curve for Plaridel (162), can be determined the approximate height of the tide at any time during the day, the duration of stand at high and low water, and other characteristics.

(2) Sun, moon, and tides.

FIGURES III - 13 to III - 24 show the rise and fall of the tides and the changing relationships during the month between the times of tide and daylight, twilight, moonlight, and darkness for Ternate (2), Davao Gulf (82), Sandakan (315), and Manado (393) for the months of June through August. The diagrams for Davao Gulf (82) are also applicable to Sarangani Bay (77) and Caraga Bay (98); those for Manado (393) to Tolitoli-baai (385); those for Sandakan (315) are applicable to Marchesa Bay (310), with the changes indicated at the bottom of the figure.

(*a*) *Area covered.* The astronomical data are for sea level and will not vary more than 5 minutes over a radius of 60 miles.

(*b*) *Time used.* The times on the diagram are for the time meridian indicated in the heading. When another time meridian is to be used in the field, it will be found convenient to change the figures representing hours on the left of the large diagram to conform to the new time. If the time meridian to be used is east of the one shown on the diagram, increase the figures by 1 hour for each 15°; if west, decrease the figures.

(*c*) *Dates.* In the upper diagram, each day from midnight to midnight is represented by a space between 2 lines. In the lower diagram the days are represented by vertical lines covering the period from noon of one day to noon of the next; therefore, the dates at the bottom differ from those at the top because the date changes in passing through midnight.

(*d*) *Tides.* The times of the tides are shown by curves in the lower diagram. By noting the sequence of the tides during a day, the height of any particular tide can be found from the upper diagram.

(*e*) *Twilight.* Three types of twilight are shown. In the evening, *civil twilight* starts at sunset and ends when the sun is 6° below the horizon. Objects can be distinguished readily, and a newspaper can be read. At the end of civil twilight, the brightness of the sky is still about 20 times as great as when the full moon is at zenith. Civil twilight is followed by *nautical twilight* which ends when the sun is 12° below the horizon. All the brighter stars are visible and general outlines can be distinguished, but the horizon will usually be indistinct. The end of nautical twilight may appear to be the beginning of solar darkness, but a small amount of light from the sun may still be refracted or reflected until the end of *astronomical twilight* when the sun is 18° below the horizon. In the morning the twilights occur in reverse order.

(*f*) *Moonlight.* During astronomical twilight and solar darkness, periods of moonlight and dim moonlight are shown. During the period of *moonlight*, the intensity of light will vary between the brightness of the full moon at zenith and about ⅓ of this value. During the period of *dim moonlight*, the intensity varies from about ⅓ to $\frac{1}{10}$ of the brightness of full moon at zenith.

(*g*) *Moon's phases.* The phases of the moon are shown below the day on which they occur.

B. Tidal and local currents.

(1) Halmahera. (FIGURE III - 1)

Ternate Island (1). The current through Ternate Roads (2) is sometimes strong. It sets northward at high water and southward at low water. Southerly winds cause a broken sea when the southward current is running. Troublesome rollers may be experienced in the roads from December to April.

Batjan (7) and Sambaki (8) Straits. The currents along the north side of Batjan Island (4) are weak, but there are cross currents at the entrance to Sambaki Strait (8). As a rule the currents in Batjan (7) and Sambaki (8) Straits seldom exceed 2 knots, though in the narrow passages a current of 3 knots is possible during spring tides. Slack water occurs at the time of high and low water at Ternate (2); the current sets northerly when the tide is rising at Ternate (2) and southerly when the tide is falling. The anchorage at Lambak Bay (9) is protected from the current.

Patinti Strait (10). The currents in the wider parts of the strait are weak, but currents are rather strong in the channels between the Koesoe Islands (11). A velocity of 4½ knots has been observed in these channels at spring tides and 3 knots at neap tides. In the channel between the Dowora Islands (12) and the Halmahera coast, the current is sometimes strong.

Libobo Point (14). The currents are strong in the passage between Libobo Point (14) and Babi Island (15) and also in the wider passage between Halmahera and Damar (16) Islands.

Weda Bay (17). Tidal currents are noticeable only close to shore. They are not strong. On the west coast they set northward with a rising tide and southward with a falling tide. Along the north shore the flood current sets westward and the ebb eastward.

Djailolo Passage (19). The principal currents in the deep and open section of the passage are the monsoon drifts, which are strong around the northwestern end of Gebe (20). There are tidal currents on the bank of soundings near Moeor (21).

Boeli Bay (24). In the outer part of the bay the monsoon drifts affect the tidal currents, and velocities of as much as 2 knots may be encountered. Inside the 100-fathom curve the currents are tidal and do not ordinarily exceed 1 knot except between the islands at the southeastern end, where they may attain a velocity of 1½ knots.

Lelai Point (26). Along the coast southward of Lelai Point (26) the monsoon drifts are the principal currents. These currents run rather strongly around the salient points.

Kaoe Bay (27). The maximum rate of the current on both sides of Boebale Island (30) is 1½ knots. When the winds blow against the current, a difficult sea is experienced. Outside the bay, currents may be encountered north and east of the Tobelo Islands (32) and along the coast south of Miti (31), but among the islands and between them and the shore there is no current of any consequence.

Galela Bay (33). In the vicinity of Galela Roads (34), the currents are negligible until 6 or 8 miles offshore, where the monsoon drifts become noticeable.

Morotai Island (35). Strong currents may be experienced off the northeast end of the island. At Gorango Point (36) a current of 3 knots has been observed on a rising tide at neaps. At springs the current may be 4 knots.

(2) Islands south of Mindanao. (FIGURE III - 1)

Talaud Islands. Strong currents have been experienced in Kaboeroeang Strait (38). The currents set northwestward along the coast at Liroeng Road (39) at high water and southeastward at low water; they may attain a velocity of from 2 to 3 knots. A strong current sets out of the river in Essang Bay (40) during heavy rains.

Sangihe Islands. Eddies occur between Siaoe (41) and Pahepa (42) Islands, where there is a current with a maximum velocity of 2½ knots. The currents are strong between the islets and reefs on the eastern side of Pahepa Island (42). Outside the bays, along the west coast of Sangihe Island (43), there is a current with a velocity of 2 knots. A current of 3 knots sets northward with the flood and southward with the ebb in the strait between Sangihe (43 and Beng-darat (45) Islands. At Peta Bay (47), on the northeast coast of Sangihe (43), strong currents can be expected.

Toade Islands (48). During November and December, a general southerly current of 1 to 2½ knots sets between and east of Toade Islands (48).

Lipang Island (49). Currents are irregular. A current of considerable strength gives rise to a violent sea as it sets across Louise Bank (50), north of Sangihe (43).

Kawio Islands. During October and November, a current with a velocity of ½ to 2½ knots sets to the south-southwest in the vicinity of the Kawio Islands. The velocity, but not the direction, is affected by the tides. Over Memanoek Bank (51), the currents are strong.

(3) Mindanao, south coast. (FIGURE III - 2)

Along the south coast of Mindanao, from Zamboanga (176) to Polloc Harbor (70), the tidal currents turn at about the times of high and low water.

Dumanquilas Bay (58) and vicinity. At Naga-Naga (56) in Port Sibulan (57) the flood current sets northward parallel to the dock face. Currents in the open channels entering Dumanquilas Bay (58) seldom exceed 1 knot, but near the shoals in the approaches are greatly intensified, forming eddies. Off Maligay Bay (60) the ebb sets eastward at 1 knot, and farther south, near Liscum Bank (61), the flood sets southeastward and the ebb southwestward at about ½ knot.

Illana Bay (62). Along the coast, the flood current sets northward, northwestward, or westward according to the configuration of the shore. The tidal currents in Illana Bay (62) run with considerable velocity, especially on the ebb. Near and eastward of Flecha Point (63) the currents are very strong and cause a heavy sea when there is any wind. In Port Sambulauan (65) the currents follow the channel, producing strong currents and eddies at its mouth. At Tuka Bay (68), on the eastern side of Illana Bay (62), the flood current sets northwestward, parallel to the coast, and the ebb sets southeastward.

Polloc Harbor (70). During the flood the current sets eastward on the shore and follows the bend of the coast southward and westward. The ebb sets in the opposite direction. At Polloc Harbor (70), tidal currents turn at high and low water. The currents in the Mindanao River (71) are strong and are felt well offshore.

Tapian Point (73). A continous weak northerly current is felt offshore, with a reverse current close inshore along the reef.

Tuna Bay (75). A continuous current of ½ to 1 knot sets to the southeast, with a current in the opposite direction close inshore.

Palimban Point (76). A moderate current, little affected by tide or winds, sets northwestward along the shore, but offshore the strong southeasterly current setting toward Sarangani Strait (78) is encountered.

Sarangani Islands (79-81). The tidal currents are strong in the vicinity of these islands. In Sarangani Strait (78) the flood sets westward and the ebb eastward. In the channel between the 2 larger islands the flood sets northward and the ebb southward. Strong eddies occur on both sides of the channel near the reef line, and heavy tide rips have been noted off each entrance. Heavy tide rips have been noted, also, south and west of Balut Island (79) and north and south of Sarangani Island (80). On the east side of Sarangani Island (80) the flood current, which is deflected by the 20-fathom bank off the southeast side of the island, sets southward with a velocity of about 3 knots.

In the channel between Sarangani Island (80) and Olanivan Island (81), the flood current sets north-northwestward and the ebb south-southeastward with considerable velocity. Opposing currents meeting in the channel create disturbed water.

Davao Gulf (82). In general the flood currents sets in a westerly direction past Cape San Agustin (92) directly towards the western shore of the gulf where, between Banos (83) and Calian (84) Points, it apparently splits, one part going southward toward Sarangani Strait (78) and the other, a slightly weaker current, northward into Davao Gulf (82). Strong tide

races and violent eddies are prevalent off Banos Point (83).

It is reported that at Davao (87), tidal currents of about 2 knots set parallel to the shore line and thus sweep at right angles to the north and south faces of the pier. Off Davao (87) and in Pakiputan Strait (88) the usual tidal current sets northward on the flood and southward on the ebb, with a velocity, at times, of 2½ knots in the narrow part of the strait. Occasionally, however, the current sets southward through the strait on both the flood and the ebb, but this usually occurs only during strong northerly winds or after a southwest blow, during which the water has been backed up into the northern end of the gulf.

In the Tagum River (89), flood currents are weak, but the ebb runs with a velocity of 2 to 4 knots.

Palmas Island. A strong southerly current splits on the bank, which extends more than a mile off the north end of the island, causing violent overfalls and boiling water in that vicinity and a considerable eddy near the reef to the southward. The anchorage on the southeast side of the island is also subject to swirls and tide rips.

(4) Mindanao, east coast. (FIGURE III - 2).

There is a constant south-going current off the east coast of Mindanao. Within a mile or so of shore there are eddies, and the direction of the currents is influenced by the tides, except near the projecting points where the direction remains constant. There are strong races off Pusan Point (97) where the currents attain their greatest force. Tide rips and swirls are encountered off most of the points on this coast.

Mayo Bay (95) to Cateel Bay (102). In Mayo Bay (95) the tidal currents are weak, but at the entrance points they come in conflict with a strong constant southerly current of about 2¼ knots; heavy tide rips and much disturbed water frequently occur. Heavy tide rips are common also off Casauman Point (96), and even in moderate weather there are heavy tide rips and swirls off Pusan Point (97), apparently caused by the constant southerly current off the east coast of Mindanao. Heavy rips and swirls frequently exist off Bagoso Island (99) and Bangai Point (100).

The waters of Cateel Bay (102) are almost free from the constant southerly current which is felt farther offshore. Strong tidal currents in the Cateel River (101) cause a confused sea near the entrance.

Sanco Point (103) to Bakulin Point (107). A. constant southerly current of moderate strength exists offshore, but in the narrow channels among the numerous coral reefs lying in the deep indentations of the coast the current is influenced by the tide, setting northward on the flood and causing many swirls and eddies.

Currents are strong in the Bislig River (105). In the Hinatuan River (106) the tidal currents are also strong and set with the channel.

Cauit Point (111). A constant southward current of 1 to 2 knots has been experienced off this point.

Bucas Grande Island (115). The currents in the southern entrance to Port Batuecas (117) run with considerable velocity.

Siargao Island. On the western side of the island, in the channels leading to Numancia (120), currents are strong and there are dangerous whirlpools at places. Currents are strong, also, in the Lumaton River which empties into Pamay Bay (121) on the west side of Siargao.

Masapelid Passage (126) and vicinity. The tidal currents have a velocity of about 2 knots in Taganaan Estero (127). They are much stronger in Masapelid Passage (126), which is on the west side of Masapelid Island (125).

Hinatuan Passage. The currents are strong and the tide rips and whirlpools are very marked in Hinatuan Passage between Mindanao and Nonoc Island (131). The flood current sets from the Pacific toward Surigao Strait (137) in a general westerly direction, and the ebb sets in the opposite direction. Violent tidal whirls have been observed in the narrow channel between Dayan Reef and the northwestern end of Bayagnan Island (128). A maximum current of about 7 knots usually occurs abreast and a little to the westward of Rasa Island (129). During the strength of the flood, tide rips are very marked in this area and also in the vicinity of Kabo Reef, the submerged reef, about 2 miles west of Rasa Island (129). The current is strongest and most violent in the channel on the north side of Rasa Island (129) and, especially during the strength of the ebb, produces bad rips and whirlpools where it joins the slower current coming around the south side of Rasa Island (129) reef. Between Rasa Island (129) and Lapinig Island (130) the slack before the eastward (ebb) current occurs about 2 hours before high water at Cebu, on Cebu Island (FIGURE III - 2), and the slack before flood about 2 hours before low water at Cebu. In the channel on the north side of Rasa Island (129) there is scarcely any slack water, the current changing from flood to ebb very quickly.

Gabo Channel. Low water at the Awasan Bay (133) end of Gabo Channel, the passage between Nonoc Island (131) and the southern end of Dinagat Island (132), comes at about the same time as high water at the Port Gabo (134) end; as a consequence there are violent and swift tidal currents with dangerous rips and whirls near all the points. Slack water occurs 2 or 3 hours later than high and low waters.

(5) Mindanao, north coast. (FIGURE III - 2)

Between Surigao Strait (137) and Camiguin Island (151) there is a constant current to the west during both monsoons, varying in strength according to wind and tide. The flood current westward through Surigao Strait passes southwest on both sides of Camiguin Island (151) with considerable velocity, but loses its strength as it enters Macajalar Bay (154). It has an estimated velocity of 2 to 3 knots during spring tides. South of Bohol Island the currents follow the direction of the prevailing monsoon. Near the coast and in the large bays the currents are influenced by the discharge from the rivers.

Surigao Strait (137). In the vicinity of Kayasa Islets (138) the tidal currents attain a velocity of 5 or 6 knots during spring tides. Tide rips off Esconchada Point (139) are marked and heavy, especially with the flood tide. South-going currents are strong off the points of Dinagat Island (132) and in the vicinity of Kanihaan Island (140), causing heavy tide rips and overfalls. North-going currents are weak.

Butuan Bay (145). The current in the Agusan River (146) is strong, and the water off the town of Butuan (147) is fresh at all stages of the tide.

Camiguin Island (151). At Mambajao (152), the flood current flows westward parallel to the pier end. Tide rips form about ½ mile northwestward of Medano Islet (153).

Macajalar Bay (154). At the town of Bugo (155) the tidal currents parallel the wharf face, flowing southward on the flood with a velocity of about 1 knot.

Iligan Bay (157). At the town of Iligan (158) the tidal currents at ebb run northward, normal to the dock, and are excep-

tionally strong when the Iligan River is in flood. At Port Misamis (159) the ebb current flows eastward across the ends of the docks.

Tagolo Point (164). Tidal currents are very strong off Tagolo Point (164), setting eastward on the flood and westward on the ebb. About 5 miles to the south, at Port Puluan (166), the ebb current flows outward from the dock ends.

Northwest coast of Zamboanga Peninsula. Tide rips occur off Lanboyan Point (167), eastward of the northeastern end of the channel between the Murcielagos Islands (169) and the mainland, and also off Coronado Point (170).

Panabutan Bay (172). It is reported that there are no currents in the bay.

Batorampon Point (174). Tidal currents set toward this point with great force.

Basilan Strait (175) and vicinity. In Basilan strait, tidal currents follow the direction of the channel; near the islands and shoals these currents follow the edge of the reefs. They may attain velocities of 5 to 6 knots. The westward strength occurs about 3 hours after low water at Cebu and the eastward strength about 3 hours after high water at Cebu. Part of the west-going current passes northward up the west coast of Mindanao until it meets the flood current from Surigao Strait (137) about midway on the coast. During a period of northerly winds, however, the current in the strait has been observed to set continuously eastward with varying velocity for 24 hours. Slack water at Zamboanga (176) occurs approximately 1 hour and 40 minutes before the corresponding high and low water at Cebu. The turn of the current takes place later in the strait than at Zamboanga (176). The change begins first on the coast of Mindanao, then in the strait, and last on the coast of Basilan. Observations in midchannel between Zamboanga (176) and Great Santa Cruz Island (177) indicate that the current at that location slackens 1 hour before low and high waters at Cebu. The westward strength occurs about 2 hours after low water and the eastward strength about 2 hours after high water at Cebu. Currents are very strong in Tictauan Channel (178), and there are usually tide rips over the shoal in the center of the channel. In Masinloc anchorage (179) the flood current sets southeastward and the ebb northeastward at the same hours as at Zamboanga (176).

(6) Sulu Archipelago. (FIGURE III - 3)

Pilas Group. Southward to Pabunuan Shoal (182) the currents are somewhat irregular, and tide rips and overfalls occur near the banks and shoals. There is very little current in the channel between Manangal (183) and Pilas (184) Islands. The currents are strong in Pilas Channel (185), reaching 6 knots during spring tides.

Basilan Island. The ebb current in Isabela (186) Channel, between Malamaui (187) and Basilan Islands, sets northeastward with a strength of 4 to 5 knots; the flood has a strength of 3 to 4 knots and flows for a considerably shorter period than the ebb. Heavy tide rips may be encountered at the entrances when the wind is against the current. At the western entrance to the channel, south of Moro Island (188), there is considerable cross current. Just westward of Malamaui Island (187) some current usually sets northward or southward but diminishes as the distance from Malamaui (187) increases. Farther to the west, at Pamelukan Bank (189), the currents are strong and irregular; tide rips are formed. The strong tidal currents that sweep through the channels of the Sulu Archipelago are not felt in Maluso Bay (190).

The Basilan Lumber Co., at Port Holland (191), reports that currents along the face of the dock lag about ½ hour behind the tides and have a maximum strength of 2 to 3 knots. They are strongest on the ebb, which sets southwestward against the face of the dock. On the flood the tidal current sets northeastward and off the wharf face.

Islands off west and south coasts of Basilan Island. The tidal currents through the channels between the islands westward of Maluso Bay (190) are irregular in direction and frequently attain velocities of over 3 knots. Between Mataja (192) and Sicagot (193) Islands the slacks occur at about the times of high and low waters at Cebu. The northward strength occurs about 3 hours after low water and the southward strength about 3 hours after high water at Cebu. Between Tamuk Island (194) and Basilan the slacks occur about 1 hour before high and low waters at Cebu. The northward strength occurs about 2 hours after low water and the southward strength about 2 hours after high water at Cebu. Tide rips and swirls occur over the shoals and off the points of the islands. There is a strong current through Bihintinusa Channel (195) on the south side of Basilan Island.

Tapiantana Group (200-203). There is a strong tidal current through Tapiantana Channel (199). The slacks occur about ¾ hour before high and low water at Cebu. The westward strength is about 2½ hours after low water and the eastward strength about 2 hours after high water at Cebu. Among the islands the current is very irregular in direction; at times a reverse current exists close inshore. In the channels between Tapiantana (201) and Bubuan (203) Islands and between Saluping (200) and Bubuan (203) Islands, currents are irregular. Heavy tide rips, which sometimes have the appearance of breakers on shoals, frequently are present in the southern entrances to these channels. Tide rips are numerous in the area southwest of Tapiantana Island (201).

Samales Group (204-208). Tidal currents are very strong in the channels, especially in those with the main axis lying northwest—southeast. Velocities of 3 knots occur in the channel between the northwest end of Tonquil Island (204) and Mamad Island (205). During strengths, the current sets northward or westward about 2 hours after low water at Cebu and southward or eastward about 2 hours after high water at Cebu. The slacks occur about 1 hour before high and low waters at Cebu. Tide rips and swirls are generally encountered near shoals and where there is an abrupt change in depth, especially when current and wind are opposed. There is very little current in the channel between Bucutua (206) and Bulan (207) Islands or off its northern entrance. Off the north side of Tonquil Island (204) in the vicinity of Gumila Reef (208) there is little or no tidal current.

Jolo Group (211-218). Tidal currents follow the coast and are very strong, up to 5 knots being experienced in the narrower channels. Through the channels between Bulicutin Island (211) and the 2 points at the mouth of Patotol Bay (212), tidal currents attain a maximum velocity of 2½ knots.

Along the coast near Jolo Harbor (214), tidal currents are generally semidiurnal and have considerable velocity. The strengths set westward about 2 hours after low water at Cebu and eastward about 2 hours after high water at Cebu. The slacks occur about 1 hour before high and low waters at Cebu. In the channels among the islands northwestward of Jolo Harbor (214) the tidal currents are rather strong.

There is considerable current in the vicinity of Sulade Island (215) off the southwest end of Jolo Island. A current of 5 knots has been observed between Sulade Island (215) and Jolo. The northwestward strength occurs about 2½ hours after low water at Cebu and the southeastward strength about 1½ hours after high water at Cebu. The slacks occur about ¾ hour before the times of high and low waters at Cebu.

Inside the shoals at Maimbung Bay (216) the current is not noticeable, but in the offing it is strong and irregular.

In the channel between Damocan (217) and Pata (218) Islands, the currents attain a velocity of 3 knots.

Tapul Group (219-225). Tidal currents are strong in the channel between Lugus (219) and Tapul (220) Islands, reaching a velocity of 6 knots, at times, in the narrow part. The currents set northwestward on the flood and southeastward on the ebb.

In the channel between Laminusa Island (221) and the eastern point of Siasi Island (222) the tidal current is very strong at springs. The flood sets from east to west and then north through the channel, the ebb from north to south and then east.

In the channel between Siasi Island (222) and Lapac Island (224) the tidal currents set northward on the flood and southward on the ebb, reaching a maximum velocity of 5 knots during springs.

The currents are strong in the channel between Lapac (224) and Tapaan (225) Islands, reaching a strength of about 6 knots during springs. There are dangerous tide rips along the southern part of the channel at the edge of deep water, wherever the strong ebb current meets a swell from seaward.

Pangutaran Group (226-231). The tidal currents over Favorite Bank (226) and Pangutaran Reef (227) are strong and irregular and generally set northward and southward with swirls and tide rips in the vicinity of the shoals. The northern edge of the banks is often marked by heavy tide rips, especially during the northeast monsoon season or when the wind is against the current.

The tidal currents run fair with Pangutaran Passage (229) and attain a maximum velocity of about 4 knots.

In the area between Pangutaran Island (228) and Cap Island (231) the tidal currents are strong over the banks, the strengths setting approximately northwestward and southeastward, but both direction and strength are modified by the many shoals in this area. In the vicinity of Sail Rock (230) the currents set almost north and south with a velocity of 3 to 4 knots. The northward strength occurs about 2¾ hours after low water at Cebu and the southward strength, about 2 hours after high water at Cebu. Slacks occur about 1 hour before high and low waters at Cebu. The current is generally semidiurnal even during periods of diurnal tides.

Cap Island (231) to Pearl Bank (235). Tidal currents take various directions around these islands and the off-lying banks and shoals. The prevailing directions of the strengths, where unobstructed, are north-northwest and south-southeast, and they may attain a velocity of 6 knots between Doc Can Island (234) and Pearl Bank (235); elsewhere the currents are somewhat weaker.

In the vicinity of Cap Island (231) and between Cap Island and Laparan Island (233) the strengths set to the north-northwest and to the south-southeast; the maximum velocity is about 3 knots.

Off the west end of Doc Can Island (234), currents follow the general direction of the 20-fathom curve. About 4 miles southwest of the island, the current entering the Sulu Sea was observed to set to the northwest; due west of the island, to the north; and north of the island, in a northeasterly direction. The current from the Sulu Sea flows southwestward from the north of Laparan Island (233) and southeastward to the south and southwest of Doc Can Island (234). Inside the 100-fathom curve south of Doc Can Island (234), it was observed to set in an east-southeasterly direction approximately parallel to the shore. Between Laparan (233) and Doc Can (234) Islands currents set parallel to the channel, northward and southward.

In the deep-water area midway between Doc Can Island (234) and Pearl Bank (235), the currents set about north and south. South of this area and of Pearl Bank (235), the sets are to the north-northwest and to the south and south-southwest. A set to the southwest has been observed 4 miles south of Pearl Bank (235). North of Pearl Bank (235) the southward current divides, part flowing to the east and part to the west of the bank. Inside the 50-fathom curve to the west, the sets are to the northwest and to the south. South and southwest of Pearl Bank (235) near the 50-fathom curve, the current from the Sulu Sea was observed to set approximately east or parallel to the depth curves..

In the area between Cap Island (231) and Pearl Bank (235), as a rule, slack water occurs from 1 hour before to 1 hour after local high or low water, but the time occasionally varies by as much as 2 or 3 hours either way, presumably because of the combined effect of Sulu Sea and Celebes Sea tides.

Moderate tide rips may be expected in bad weather, as well as strong currents at the edges of all banks. Moderate tide rips have been observed off the west shore of Cap Island (231), south and west of Deatobato Island (232), in the channel between Laparan (233) and Doc Can (234) Islands, between Doc Can Island (234) and Pearl Bank (235), and at the edges of the bank west of Pearl Bank (235).

Very heavy tide rips have been observed between and at the edges of the shoal extending west from Doc Can Island (234) and the shoal to the northeast of Pearl Bank (235). On a calm day a line of 3-foot tide rips was observed extending from Doc Can Island (234) nearly to Pearl Bank (235).

Dammai Island (236) and vicinity. Currents take various directions near the islands and shoals in the vicinity of Dammai Island (236), but in the unobstructed areas the strengths set to the north-northwest and to the south-southeast. The strength will rarely exceed 2 knots. Slack water generally occurs about 1 hour after high and low water.

Islands east of Tawitawi (239-256). The average direction of flow of tidal currents in the area east of Tawitawi Island is northwest with the flood and southeast with the ebb, although this direction varies somewhat in different passages and channels. In the vicinity of Cacatan Island (241) and Midchannel Bank (242), currents set parallel to the channels. The flood, entering Tapaan Passage (244), sets in a north-northwest direction, the ebb in the reverse direction. Currents flow in the passages between the islands west of Kinapusan Island (245) parallel to the axes of the channels, but north of the channels they are deviated to the west with the flood. In the area north of the Kinapusan Islands (245) and south of Tagao Island (246), the flood sets to the west-northwest and the ebb in the reverse direction. This flood current progresses as far as the vicinity of Bakeke (250) and Baturapac (251) Islands before

it is turned to the northwest. This current meets the flood flowing to the north through Tandungan Channel (249) at about the latitude of the north end of Tandungan Island (248).

In the open-water areas tidal currents only occasionally exceed 2 knots, but in the channel between Tumbagaan (239) and Sugbai (240) Islands, in Tapaan Passage (244), and in the passages between the islands west of Kinapusan Island (245), currents may attain a maximum velocity of 6 knots.

To the northeast, currents attaining a velocity of 5 knots are found in the channel westward of Pasegan Guimba (247). In Calaitan Channel (252), the currents sometimes reach a velocity of 4 knots and are very bad, especially at the junction of Calaitan (252) and Sipungut (253) Channels with Tandungan Channel (249).

Offshore, southeast of Tandubas (254) and Secubun (255) Islands, the tidal currents flow parallel to the reef edge with a velocity of about 1 to 2 knots; the flood sets northeastward. Through the reefs, the currents set fair with the channels, with a maximum velocity of 6 knots.

At the southwest end of Tandungan Channel (249), the tidal currents, in the channel between Bauang Dakula (256) and the islands northward, reach a velocity of 4 to 5 knots in restricted areas during spring tides. At high water there are cross currents setting on the reefs, particularly on the flood. On the falling tide and at low water the flow is along the channel axis.

In unfavorable weather, heavy tide rips will be met in the channel between Tumbagaan (239) and Sugbai (240) Islands, in Sugbai Passage (243), Tapaan Passage (244), in the vicinity of Kinapusan Island (245), and at the south entrance to channels between the islands west of Kinapusan Island (245). These tide rips are generally heaviest where general depths considerably increase or decrease abruptly, as at the south entrance to channels between the Kinapusan Islands (245).

Tawitawi Bay (258) and vicinity. Among the islands and shoals south of Tawitawi Island, the general direction of the flood is northwest, but deviates to conform to definite channels. In the eastern part of Tawitawi Bay (258) the currents set northward on the flood and southward on the ebb at a velocity of about 3 knots. Off the northwest end of Banaran Island (259) the current is reported to be less than 2 knots.

Tidal currents are not very strong in Balimbing Channel (260) north of Bilatan Island (261). The currents coming from the western part of Tawitawi Bay (258) set fair with the channel.

Southeast of Tawitawi Bay (258) in deep water, currents are weak and irregular. In Balseyro Channel (262) the currents are strong and the water frequently is roiled. To the southward, in Simunul Channel (263), the currents are strong and set fair with the channel. Near Laa Island (266) the currents set northeast and southwest with an average velocity of 3 knots. There is little current in Batu Batu Bay (267) or Luuk Sula Bay (268). Outside, the tidal current sets northeastward on the flood.

Entering Tawitawi Bay (258), a 3 to 5 knot current may be encountered with strong eddies and rips which will twirl a destroyer. Course at 15 knots speed must be altered 20 to 30 degrees. After passing through the rips the current sets to the east on the ebb and to the west on the flood.

Whirlpools and tide rips are found in the vicinity of Manuk Manka (264) and Simunul (265) Islands. Off Bongao (270) the current sets northwestward and southeastward. Tide rips are frequent off Tampat Point (271) on Bongao Island (270).

Tawitawi, north coast. Tidal currents along the north coast of Tawitawi Island are weak. The flood current from Sibutu Passage (278) sets northeastward along the north coast, meeting the flood from east of Tawitawi in longitude 120°11′ E.

On the northwest side of Sanga Sanga Island (272) the tidal currents flow north and south at a velocity of 2 to 3 knots.

In the small channel between Bato Bato (274) and Bakhau Dakula (275) Islands the currents attain a velocity of 4 to 5 knots. In the channel west of Bakhau Dakula Island (275) the currents are weak. The flood tidal current apparently sets into both north and south ends of Luuk Saul (276), the north end of Manalik Channel (273), beginning about 3 hours after low water. The ebb sets outward, beginning about 2 hours after high water.

In Tataan Pass (277) the flood sets northeastward and attains a velocity of 1 knot.

Sibutu Passage (278). The currents in the passage generally set north-northwestward on the flood and south-southeastward on the ebb, slack water usually occurring within 1 to 2 hours of low or high water. The south-going current is much stronger, presumably because of the permanent Borneo coast current. The flood current through the passage is deviated to an easterly or southeasterly direction off the northwestern coasts of Bongao (270) and Sanga Sanga (272) Islands.

During the period of the southwest monsoon the flood sets northward and the ebb southward, but the current has been observed to lag several hours behind the change of the tides. Currents at this time varied in strength from 0 to 4 knots.

During part of the period of the northeast monsoon, the current was observed to set continuously to the south. Its strength varied from a slight amount to an estimated 6 knots.

On several patrols southeast of Sibutu (279) the current was observed to set eastward or westward at 2 to 4 knots—westward when the current in the passage is to the north, and eastward when the current in the passage is to the south. This is a pronounced tidal current; considering the southerly current as the ebb, maximum ebb and flood occur about ½ hour after and before ebb and flood at Tawitawi.

Sibutu Group (279-287). The currents in the various channels west of Sibutu Island (279) follow the trend of the channels and have been observed to have the same lag as those in Sibutu Passage (278).

In Tumindao Channel (280) the flood current sets southward and the ebb northward, attaining velocities of 2 to 4 knots at springs. The currents change approximately at the times of high and low waters at the shore. Strong currents sweep around the ends of Sibutu Island (279). There are strong currents in the channel which leads into North Lagoon (282).

Currents of 2 to 4 knots have been experienced in Meridian Channel (283). The currents change approximately at high and low waters at the shore. The maximum current near Purdie Patches (284), at the north end of the channel, is less than 2 knots. At the south end of the channel, on the edge of the bank southwest of Frances Reef (287), there are strong tide rips and overfalls. The flood current which runs here with exceptional strength, frequently with a velocity of 3 knots, sets southward and southeastward over the edge of the bank.

The tidal currents run strongly in the channels in the vicinity of Bajapa (285) and Riddells (286) Reefs: the flood sets

southward and westward and the ebb northward and eastward with a velocity of 2 to 2½ knots.

(7) Borneo, northwest coast. (FIGURE III - 4).

Brunei Bay (288). Tidal currents off the coast are weak, having a velocity of about ½ knot; the flood sets to the southwest, the ebb to the northeast following the coast. They are often masked by the monsoon drifts. During the southwest monsoon, the current off the western coast of Labuan (289) sets continuously northeastward, running parallel to the coast at a rate of ½ to 1 knot. In November, with light winds, the current occasionally sets southeastward. In Keraman Channel (290), tidal currents are sometimes very strong.

Kimanis Bay (291). In November, off the mouth of the Papar River (292), a northwestward set of ½ knot was observed. The tidal currents off the southeast extremity of Tiga Island (293) are irregular and are influenced by currents in the offing, set up by temporary or constant winds. The ebb runs east-northeastward; the flood occasionally flows southwestward. In December the current ordinarily sets between east-northeast and southeast and attains a velocity exceeding ¾ knot.

Gaya Bay and Jesselton Harbor (295). Offshore from June to December, the set has been observed to be northeasterly with a velocity varying from ½ to 1½ knots.

Usukan Island (296) to Sampanmangio Point (299). The coast between Usukan Island (296) and Makarang Point (297) is subject to heavy rollers. From Tambaluran Point (298) to Sampanmangio Point (299), the rollers are heavy along the shore. Off Sampanmangio Point (299) during the summer, the current has been observed to set in a continuous northeasterly direction at a velocity seldom exceeding 1 knot.

Balabac Strait (303). The flood current sets to the east, the ebb to the west, at a maximum rate of 2½ knots. The velocity of both currents is much influenced by the winds. After a succession of westerly winds in October and November, the current sets constantly to the east, slackening only on ebb; while in July, after unusually fine weather, it sets in the opposite direction at the same strength, ¾ to 2½ knots.

In Banguey South Channel (305) there are heavy tide rips ⅓ mile south of Ten Foot Rock (306). Heavy tide rips occur also in Mallawalle Channel (307) 1 mile east-northeastward of Passage Reef (308). In the channel the flood runs eastward, the ebb westward, with a velocity of 2½ knots at springs.

(8) Borneo, east coast. (FIGURE III - 4)

Labuk River (312). The maximum velocity of the ebb is 3 knots. Tidal influence is felt in the river 20 miles from the entrance.

Sandakan (315). Taganak Patches (313) are occasionally marked by tide ripples. Strong currents are reported in the vicinity of Taganak Island (314), off Sandakan (315). The tidal currents in Sandakan Harbor (316) turn at high and low water, the ebb attaining a maximum velocity of 2 knots at springs, and the flood, 1¼ knots. Along the wharf, the current frequently sets in a reverse direction to that in the harbor.

Sandakan (315) to Dent Haven (320). Between Sandakan (315) and Tambisan (317), the flood current sets northwestward and the ebb southeastward, rarely attaining a rate of 1 knot. Between Tambisan (317) and Dent Haven (320) the currents are stronger, the flood setting to the north and the ebb to the south at a rate of 2 to 3 knots. Ten miles from the coast there is a southeasterly current which increases during ebb and slackens during flood.

At Sentry Bank (318), there is an almost constant set between northeast and southeast at a rate of ¼ to 1½ knots, the velocity being influenced by the tides.

Dent Haven (320) and vicinity. In Dent Haven (320), the current sets northward 3 hours before high water and southward 3 hours before low water. Between Dent Haven (320) and Labian Point (321) the currents run at a rate of 1½ to 3 knots. Both velocity and direction of the currents are variable in this vicinity.

Darvel Bay (322). The flood generally flows in a southerly and westerly direction, and the ebb to the north and east. However, these directions may vary. They turn at the times of high and low water. Along the north shore, the westerly flood and easterly ebb attain a rate of 1 knot at springs, while at the south shore, the currents have little velocity and are variable in direction. At Tatagan Island (325) and around Baturua Reef (326) the tidal currents run very strongly.

Sibuko Bay (332). Between Bum Bum Island (327) and Beaufort Reef (328), the flood sets to the south and west, and the ebb to the north and east with considerable strength at springs. In Ligitan Channel (329), the currents have the same direction and a velocity of 1 knot at springs. There are heavy overfalls on the east side of the reef of the Ligitan Group (330). South of Ligitan Island (331) the current runs at 2 to 3 knots, creating whirls and heavy overfalls.

At Treacher Passage, between Bum Bum Island (327) and the mainland, the flood current sets southward, the ebb northward at 3 or 4 knots at springs. The maximum velocity is attained in the northern part of the channel.

In Friedrich Haven (333), west of Ligitan Channel (329), the currents have a velocity of ¾ knot. The flood sets to the southwest, the ebb to the northeast. South of English Spit (334) the flood current sets west-northwestward at ½ knot and the ebb, east-southeastward at ¾ knot. Off the eastern extremity of Sebatik Island (338), the flood current sets northwestward at 1¼ knots, and the ebb southeastward at 1½ knots. Currents 2 knots stronger than these occur off Tinagat Rock (335).

The ebb current off Tawau (336) begins ½ hour after high water, and attains a maximum velocity of 2¾ knots at springs. The flood commences ¾ hour after low water and has a maximum rate of 1¾ knots at springs.

West of Sebatik Island (338), in Coal Mine Reach (340), the ebb current begins 1 hour after high water and attains a maximum velocity of 2½ knots at half tide during springs. The flood commences 1¼ hours after low water and has a maximum velocity of 2¾ knots at springs. At times both ebb and flood run at a rate of 3½ knots off Grassy Point (339) and off the disused pier.

The velocity attained in the Kalabakang River (341) is ½ knot, in the Simandalan (344) and Serudong (346) Rivers about 1 knot. The ebb current, at springs, sets sharply around Adolphy Point (343) at the mouth of the Simandalan (344) and over Pilot Bank (342). In Merlin Channel (345), which connects the Simandalan (344) and the Serudong (346), tidal currents enter from both directions but do not exceed a rate of 1 knot.

The Siboekoe River (347) is reported to have a bore above the village, Pangeran Anan (not located on the chart). It occurs shortly after low water from about 3 days before to 3 days after spring tides. The advance of the wave is rapid and can be heard a considerable distance up the river. The velocity of the flood and ebb currents at springs is 3½ knots.

Sesajap River (348). In the delta, both flood and ebb currents are strong, the ebb attaining a velocity exceeding 3 knots after a heavy rainfall. Tidal currents are felt as far up the river as Malinau (349).

Boenjoe or Tanahmerah (350) *and Tarakan* (351) *Islands.* On the outer side of Boenjoe of Tanahmerah (350) and Tarakan (351) Islands, the current flows uninterruptedly to the south-southwest or southwest at a rate of ½ knot during flood and 2 knots during ebb. In Tarakan Anchorage (352), a current of 4 knots has been observed. Eastward of Menoeloen (353), the flood current sets strongly northward and the ebb southward.

Boeloengan River (357) *and vicinity.* Generally the flood current is noticeable as far as the Belugau River (359) and toward spring tides, as far as Selor Point (360). The general strength of the flood is 1½ knots and the ebb 2½ knots; at the Belugau River (359), the ebb may reach 4 knots after floods caused by heavy rains.

At the Temenggah River (356), the channel west of Mening (355), the flood sets southward and the ebb northward and they turn about the times of high and low water.

At the mouth of the Makapan (354), the flood current sets west-northwestward about 1 hour after low water, and the ebb sets east-southeastward about the time of high water.

Maratoea Island (361). The prevailing southeasterly current sets across the reef off the southeastern extremity of the island. Near the southern point there is a strong northerly counter-current. Strong tidal currents are felt off the southern end of Bahaba Point (362), particularly at springs; at the entrance to the anchorage a short sea is caused by a southeasterly current.

To the west, at Kakaban Island (363), the prevailing southeasterly current sometimes attains a velocity of 2½ knots. At Malalungan Reef (365), to the southwest, the current generally sets southeastward along both sides of the reef, but occasionally there is an eddy to the north along the western side. At springs, the east-southeasterly ebb current from Pantai Mouth (371) is noticeable east of Malalungan.

Beraoe River (367). In the Beraoe River (367), the ebb and flood currents run 7 and 5 hours, respectively. The ebb begins ½ hour after high water, attaining a rate of 3 knots at springs and 1½ knots at neaps; the flood commences ½ hour after low water and has a velocity of 2 knots at springs and 1 knot at neaps.

Northeastward from the mouth of the Beraoe River (367), between Derawan Island (366) and the shore, the flood current runs southward, the ebb northward. East of the reef surrounding the island a southeasterly oceanic current runs at a rate seldom exceeding 1 knot.

In the channel east of Goentoeng Island (370), between the outer buoy and inner light buoy, the direction of the tidal currents conforms with that of the channel; between the inner light buoy and the east point of Goentoeng Island (370), the flood sets west-northwestward and the ebb east-southeastward.

Tandjoeng-boeajaboeaja Island (372). The tidal currents are weak at the anchorage.

Mangkalihat Point (373). In the great bight southward of Mangkalihat Point (373) there is a constant eddy in a northerly direction along the coast of Borneo, with a rate of ½ knot; just outside this point there is a constant south-going current.

Sangkoelirang Bay (374). The tidal currents in the bay are negligible.

(9) Celebes, north and west coasts. (FIGURE III - 5)

Along the northern coast, the currents appear to be irregular and fairly strong, especially between Stroomen-kaap (388) and Manado (393). In June, an east-southeasterly tidal current, with a rate of 2½ to 3 knots at neaps, was observed. There appears to be a continuous eastward drift along this coast.

Toegoean Island (378). There is an irregular current of 2 to 2½ knots in the channel between Toegoean (378) and Mapoeti (377) Islands and also in the passage eastward to Mapoeti Islands (377).

Dondo Bay (381). A strong current frequently sets by Lingian Island (379), which is just west of Dondo Point (380). Strong currents have also been observed in the passage between Simatang Island (383) and Babandji Point (382). North of Dondo Bay (381) the current frequently sets to the north past Paligisan Point (384).

Kapas Strait (387). A current of 1 to 2 knots runs through this passage between Silando Islands (386) and Stroomen-kaap (388) on the northwestern point of Celebes.

Kandi Point (389). Immediately east of Kandi Point (389) there is a strong current.

Manado Bay (393). After heavy rains, there is generally a very strong outflow from Manado River.

Naeng-besar (394). Breakers and tide rips mark the edge of the reef around Naeng Besar (394).

Bangka Strait (396). The flood current runs westward, the ebb eastward through Bangka Strait (396). Between Bangka Island (400) and Poeisan Point (401) the velocity is from 2 to 3 knots. The flood sets westerly south of Gangga (397) and Talise (398) Islands. Between Talise (398) and Bangka (400) Islands it sets northward forming rips off the north point of Talise (398) where it meets the current that flows northeastward along the north coast of Celebes.

Near the eastern shore of Talise (398) the tidal currents are weak except between Talise (398) and Kinabahoetan (399) Islands where they are sometimes very strong.

There are rips off all the salient points in Bangka Strait and heavy races to the north and northeast of Bangka Island (400).

(10) Celebes, east coast. (FIGURE III - 5)

Lembeh Island (403). Between Bentenan (405) and Lembeh (403) Islands, there is a constant northerly set along the coast with a rate of 1 to 1½ knots.

Through Lembeh Strait (402), the flood current sets northward and the ebb southward at a rate of 3 to 4 knots at springs in the narrowest parts.

Tomini Gulf. Little or no tidal current has been observed in the gulf, but along the edge of the barrier reef fairly strong tidal currents have been encountered. There is also a strong current running out of the river in Gorontalo Bay (408) on the north side of the gulf.

C. General circulation.

There is remarkably little seasonal change in the circulation of the surface water of the Celebes Sea, but the adjacent areas are more affected by the monsoon drifts (FIGURES III - 7 and III - 8). By far the greatest amount of water flowing into the Celebes Sea passes in a southwesterly direction through the passage between the southeast coast of Mindanao and the Talaud Islands; the axis of this drift is near the coast of Mindanao, and strong currents are frequently encountered close inshore. After

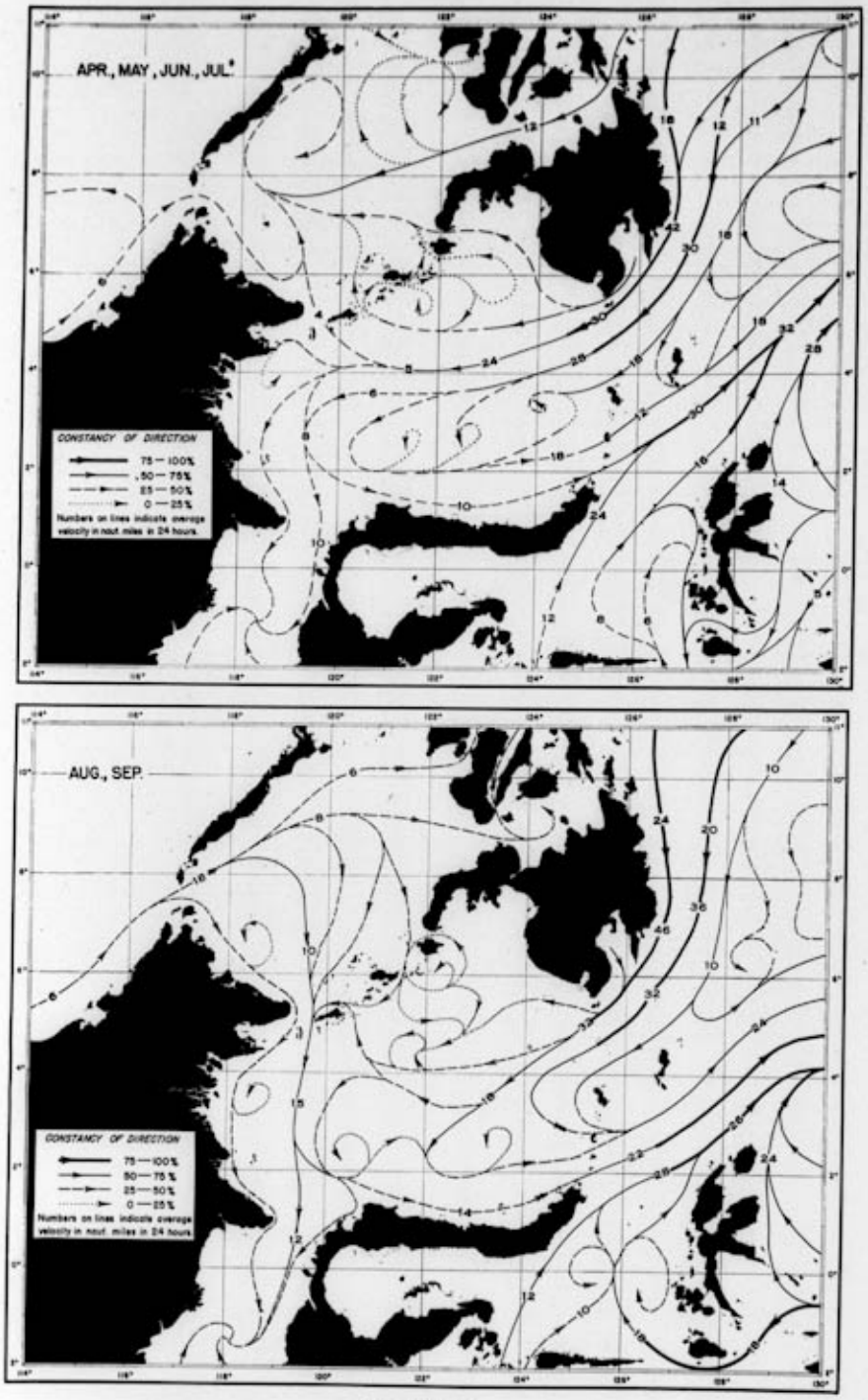

FIGURE III - 7.
Surface currents, April to September.

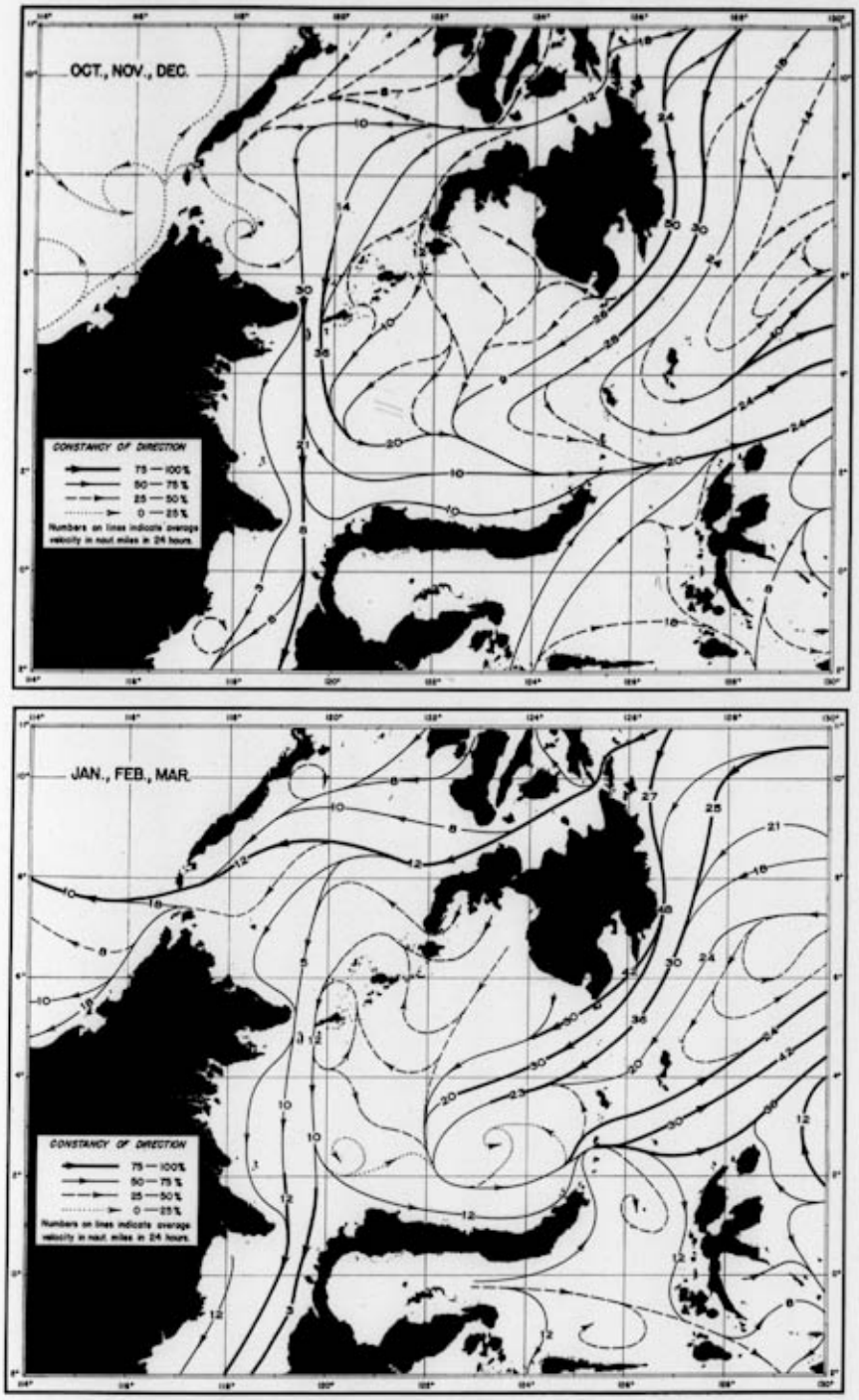

FIGURE III - 8.
Surface currents, October to March.

entering the Celebes Sea the water moves in a general counterclockwise direction and passes out of the area off the north coast of Celebes and through the northeastern part of Molucca Passage. During the southwest monsoon, from May to October, there is a more or less constant westerly drift across the north central part of the Celebes Sea, but during the northeast monsoon, from November to March, this current turns southward and joins the easterly drift off the north coast of Celebes near longitude 122° E. The current north of Celebes, however, has an easterly set throughout the year.

During the northeast monsoon there is a rather constant westerly or southwesterly set through the Mindanao and Sulu Seas, but during the height of the southwest monsoon, in August and September, the direction of this drift is reversed.

There is usually a southerly drift from the Sulu Sea into the Celebes Sea through Sibutu Passage (278) and other straits in the Sulu Archipelago, but there is apparently a flow in the opposite direction during spring and early summer.

A southerly set out of the Celebes Sea through Makassar Strait characterizes the northeast monsoon, and this current usually persists through the southwest monsoon, although it is less constant during the spring and summer months because of an opposing drift in the southern part of Makassar Strait.

There is a northeasterly current throughout the year in the western part of Molucca Passage between Celebes and Halmahera, but there may be southerly sets in the eastern part of this passage, particularly during the northeast monsoon.

32. *Sea and Swell.*

The appearance of the surface of the ocean is described by the terms sea and swell. *Sea* refers to waves caused by local winds, whereas *swell* refers to waves which have progressed beyond the influence of the winds. The direction of sea is usually determined by the wind, whereas the direction of swell may be entirely independent of the wind. It frequently happens that both sea and swell are present at the same time.

The data for sea and swell apply to offshore conditions. Information of this type is desirable in planning operations requiring aircraft carriers, as well as those requiring the transfer of personnel and heavy equipment from large to small vessels. This information will also lead to a more accurate estimate of the effectiveness of sound-ranging equipment; a rough sea will cause a high background-noise level and variations in the stratification of the water layers, which may produce differences in the ranges obtained by sound equipment.

Although at present the exact relationship between surf and offshore sea and swell is not known, the following generalizations will help in making an estimate of surf conditions if the sea and swell conditions are known. (1) There is an abrupt increase in wave height where the depth of the water is less than 1/2 of the wave length in deep water. (2) The waves break where the depth of the water is approximately 1 to 3 times the wave height in deep water. (3) The breaker height is greater than the height of offshore waves, and it will vary with different beach gradients.

The sea and swell data used for this study consist of ships' observations for the following 4 areas. (1) Molucca Passage and Pacific Ocean, (2) Sulu Sea, (3) South China Sea (northwest coast of Borneo), and (4) Celebes Sea. (FIGURES III - 9 and III - 10).

A. Sea.

(1) Amounts of sea.

The monthly variation in the amounts of sea is shown in FIGURE III - 9. The 4 areas differ slightly in the monthly distribution of the amounts of sea but, in general, the sea is least disturbed during April, May, and June and is roughest during December and January. Calms and low seas (amount 2 or less) occur more than 50% of the time. High seas (greater than amount 5) have never been recorded for the Celebes Sea area; they occur more frequently along the northwest coast of Borneo than in the other 2 areas.

In TABLE III - 1 are shown the amounts of sea for the 4 areas during the 2 monsoon seasons, November through April (northeast monsoon) and may through October (southwest monsoon).

TABLE III - 1
AMOUNTS OF SEA DURING MONSOON SEASONS

AREA		Percentage of Observations				No. of Observations
		CALM	LOW	MEDIUM	HIGH	
1	Nov.-Apr.	7	61	30	2	127
	May -Oct.	8	69	20	3	186
2	Nov.-Apr.	10	52	36	2	256
	May -Oct.	19	60	19	2	236
3	Nov.-Apr.	11	43	41	5	211
	May -Oct.	6	52	37	5	164
4	Nov.-Apr.	22	65	13	—	157
	May -Oct.	22	68	10	—	172

Although low seas predominate throughout the year, there is a greater percentage of low seas from May through October than during the winter months. Conversely, there is a greater percentage of medium seas from November through April than in the summer months. There is no seasonal variation in the percentage of high seas in the 3 areas in which they have been recorded.

(2) Direction of seas.

A monthly analysis of seas by direction cannot be made from the available data, but the summary in TABLE III - 2 shows the seasonal distribution of seas by the direction from which they come.

TABLE III - 2
SEASONAL DISTRIBUTION OF SEA BY SOURCE DIRECTIONS

AREA		Percentage of Observations								No. of Observations
		CALM	NE	E	SE	S	SW	W	NW	N	
1	Nov.-Apr.	7	40	17	4	6	6	9	5	6	127
	May -Oct.	8	4	8	16	20	28	10	3	3	186
2	Nov.-Apr.	10	46	16	4	1	2	2	4	15	256
	May -Oct.	19	6	12	10	17	16	13	4	3	236
3	Nov.-Apr.	11	55	17	2	2	4	1	1	7	211
	May -Oct.	6	10	12	3	10	41	14	3	1	164
4	Nov.-Apr.	22	25	9	5	1	7	9	8	14	157
	May -Oct.	22	8	10	11	16	21	6	6	1	172

The seas are predominantly from the northeast from November through April and from the south or southwest during the rest of the year. In general, the direction of the seas is more variable from May through October than from November through April.

(3) Relationship between wind and sea.

The tabulation of winds by direction (TABLE III - 3) shows

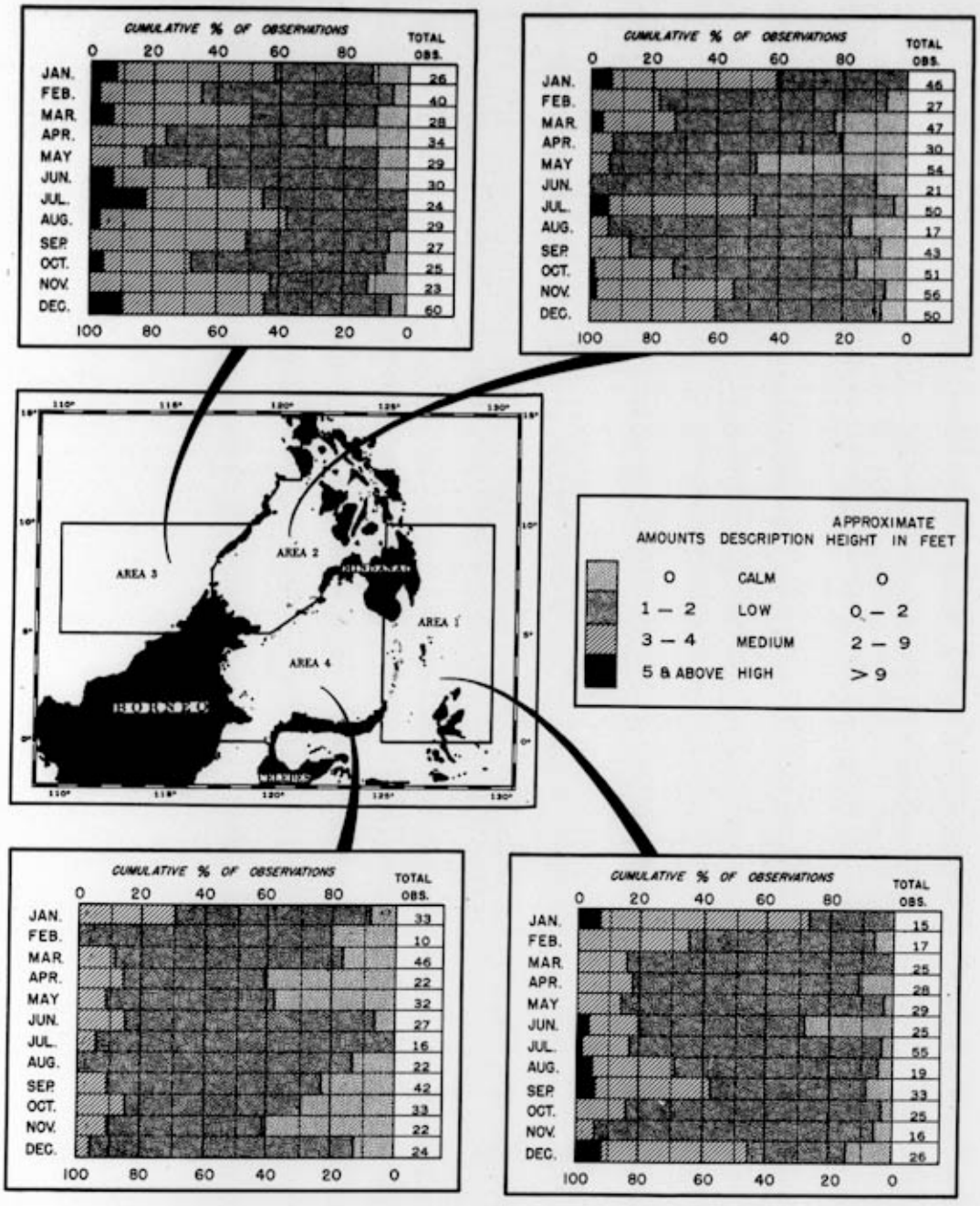

FIGURE III - 9.
Frequency distribution of amounts of sea.

a definite correlation with the compilation of seas by direction (TABLE III - 2).

TABLE III - 3
SEASONAL DISTRIBUTION OF WIND BY SOURCE DIRECTIONS

AREA		Percentage of Observations									No. of Observations
		CALM	NE	E	SE	S	SW	W	NW	N	
1	Nov.-Apr.	5	34	5	2	5	6	8	11	24	433
	May-Oct.	8	8	8	15	27	20	7	5	2	465
2	Nov.-Apr.	7	36	7	5	4	6	6	7	22	1017
	May-Oct.	10	7	7	10	17	24	13	5	7	1048
3	Nov.-Apr.	3	50	6	3	3	5	4	4	22	898
	May-Oct.	5	9	6	5	11	41	12	5	6	890
4	Nov.-Apr.	7	26	9	5	4	9	11	14	15	445
	May-Oct.	10	7	10	13	20	20	8	5	7	515

The prevailing direction of both winds and seas is northeast from November through April and south or southwest from October through May. The degree of correlation is greater in the winter season because the northeast monsoon is the stronger. This is shown by the greater frequency of medium, rather than low or calm, seas during the winter months.

Although the data for wind force are not so complete as those for wind direction, there is a correlation between wind velocity and height of sea. The average wind velocity is 8 knots or less except in Area 3, which area has a slightly higher wind velocity than the other 3 areas and also has the greatest percentage of medium and high seas. The percentage of calms (wind) is highest in Areas 2 and 4; these areas also have the greater percentage of calm seas and the smaller percentage of high seas.

B. Swell.

(1) Amount of swell.

The percentage distribution of swell by amount is shown for each of the 4 areas in FIGURE III - 10. Although swell of amount 5 is a long, moderate swell, it is indicated separately since it is desirable to include it with high swell for some purposes. The partially enclosed Sulu (Area 2) and Celebes (Area 4) Seas have a higher percentage frequency of calm than either the Molucca Passage and Pacific Ocean (Area 1) or the South China Sea (Area 3). Low swell predominates throughout all the areas. Tabulation of the data by monsoon seasons shows the seasonal variation in amount of swell (TABLE III - 4).

TABLE III - 4
AMOUNTS OF SWELL DURING MONSOON SEASONS

AREA		Percentage of Observations					No. of Observations
		NO SWELL	LOW	MOD.	AMT. 5	HIGH	
1	Nov.-Apr.	21	49	24	5	3	122
	May-Oct.	39	48	10	2	1	137
2	Nov.-Apr.	43	28	26	1	2	191
	May-Oct.	71	26	2	—	1	178
3	Nov.-Apr.	23	46	25	2	4	173
	May-Oct.	28	43	18	4	7	112
4	Nov.-Apr.	57	40	2	—	1	113
	May-Oct.	60	36	3	—	1	142

During the northeast monsoon season (November through April) there is a larger percentage of moderate and high swell in Areas 1 and 2 than during the southwest monsoon season. Areas 3 and 4 do not show very great seasonal variation. Area 3 has a higher percentage of moderate and high swell than any of the other areas, especially from May through October. Area 4 has the least swell of all the areas, with 96-97% of amounts 2 or less throughout the year.

(2) Direction of swell.

The data are too few to give a monthly distribution of amounts of swell by the direction from which it comes, but, TABLE III - 5 shows the seasonal distribution.

TABLE III - 5
SEASONAL DISTRIBUTION OF SWELL BY SOURCE DIRECTIONS

AREA		Percentage of Observations									No. of Observations
		NO SWELL	NE	E	SE	S	SW	W	NW	N	
1	Nov.-Apr.	21	46	12	5	2	1	8	2	3	122
	May-Oct.	39	6	6	9	16	15	3	2	4	137
2	Nov.-Apr.	43	32	6	3	—	2	1	3	10	191
	May-Oct.	71	3	2	3	4	8	6	2	1	178
3	Nov.-Apr.	23	45	9	1	—	2	1	2	17	173
	May-Oct.	28	9	7	1	2	33	14	3	3	112
4	Nov.-Apr.	57	17	6	2	—	2	5	4	7	113
	May-Oct.	60	2	4	6	9	15	2	1	1	142

The prevailing direction from November through April is northeast. From May through October the prevailing direction is south or southwest. The percentage of observations of no swell is greater, and the directions are somewhat more variable from May through October than from November through April.

33. *Sea-Water Characteristics*

A. Surface and subsurface temperature.

The annual variation of surface-water temperature, when combined with synoptic meteorological data, is useful in forecasting fog and in other weather forecasting. Extremes of water temperature, which affect the performance of personnel and equipment, must be taken into account in planning amphibious operations. Subsurface temperature gradients in the open sea are the chief factors in determining the paths of sound rays, and thus delimit the effectiveness of underwater sound-ranging equipment. Familiarity with these conditions, therefore, will aid a submarine to avoid detection by diving to the optimum depth and, conversely, will inform surface vessels concerning ranges and depths at which enemy submarines are likely to be encountered.

(1) Seasonal variation of surface temperature.

(*a*) *Horizontal distribution.* There is no significant horizontal variation in surface temperature in this area.

(*b*) *Temperature range.* Extreme temperatures at the surface range from 76° to 88° F. The annual mean monthly surface temperatures range from about 82° F. in February to about 85° F. in May and June.

(*c*) *Ice.* There is no ice in this area.

(*d*) *Relationship between sea and air temperatures.* Mean sea and air temperatures usually do not differ by more than 3° F. during any month of the year. Sea surface temperatures are generally higher than air temperatures.

(*e*) *Fog.* There is no fog in this area, but mist or haze may be encountered occasionally.

(2) Variation of temperature with depth.

The average temperature at 300 feet is 73.7° F.; the range

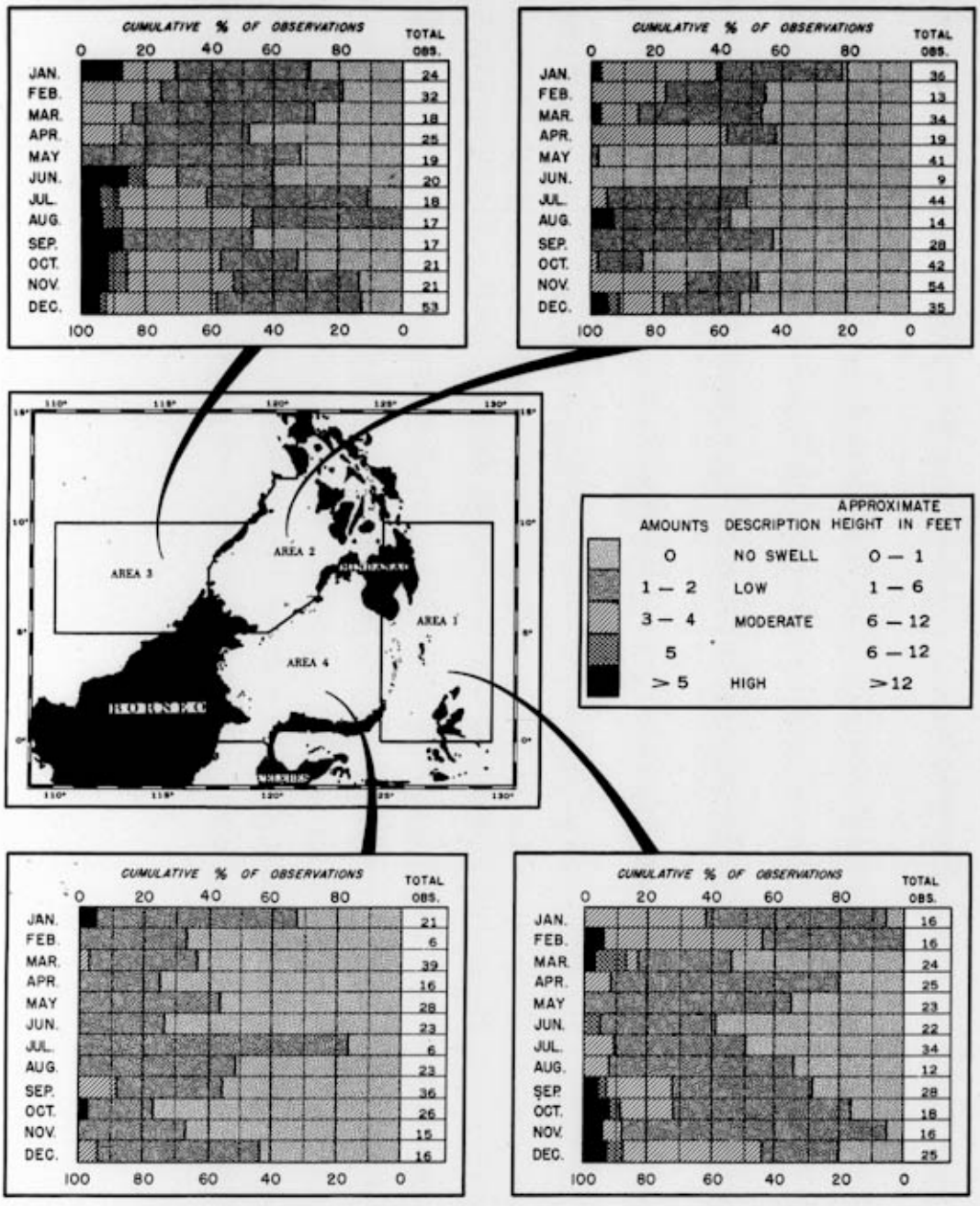

FIGURE III - 10.
Frequency distribution of amounts of swell.

is from 60° to 84° F., which is somewhat greater than the range at the surface. There is less seasonal variation at 300 feet than that at the surface, but the highest temperatures occur in June. The temperature at 300 feet may be as much as 28° F. lower than that of the surface water, but the average difference is 9.4° F. The temperature is usually constant to depths of 150-175 feet and may be constant to depths of 300 feet or more on occasion; temperature gradients just below the surface are not common. The maximum reported temperature gradient per 100 feet is 13° F.

B. Surface and subsurface salinity.

Salinity changes in surface waters near shore may affect water circulatory systems and electrical systems that utilize the conductivity of sea water. Marked variations of salinity with depth in the open sea will increase the density gradients sufficiently to alter the trim of a submarine when diving.

(1) Seasonal variation of surface salinity.

(*a*) *Horizontal distribution.* In northern summer (June, July, and August) salinity values between 33 and 34 parts per thousand are found in the Sulu Sea and Tomini Gulf; throughout the remainder of the area salinity values exceed 34 parts per thousand. In northern winter salinity values are generally lower; salinities of 34 parts per thousand or above are found only in the Molucca Sea and in the Pacific Ocean. During this season salinity values generally decrease from northeast to southwest, with a minimum value of 31 parts per thousand in Makassar Strait.

(*b*) *Salinity range.* The mean annual surface salinity is 34.03 parts per thousand. Extreme values of 30.91 and 36.20 parts per thousand have been recorded, but salinities below 32.50 and above 34.75 parts per thousand are uncommon. Surface salinity near the islands may be appreciably lower than in the open seas, owing to fresh-water runoff.

(*c*) *Electrical conductivity.* The average conductivity at the surface is about 0.057 reciprocal ohms, with extremes of 0.047 and 0.070 reciprocal ohms.

(2) Variation of salinity with depth.

The average salinity at a depth of 300 feet is 34.62 parts per thousand, 0.59 parts per thousand higher than at the surface. The minimum value at 300 feet is 33.20 and the maximum 37.74 parts per thousand.

C. Density.

(1) Horizontal distribution of surface density.

Sea surface density values in the open sea are similar throughout the area, averaging about 1.0215. However, submarines have reported that when patrolling near the mouths of large rivers and near shore, localized areas are sometimes encountered in which the density changes suddenly, probably because of incomplete mixing of inflowing fresh-water with the sea water.

(2) Variation of density with depth.

The density gradients in this area depend largely upon the variation of temperature with depth as the salinity gradient is negligible.

(3) Use of density gradients by submarines.

Density layers requiring ballast changes of 2,000 to 19,000 pounds are frequently encountered below 100 feet. The average depth at which these density layers occur is about 150 feet. There is considerable variation in the development of these layers, but there is no indication from submarine reports of a predictable seasonal change. It is improbable that submarines will be able to balance on these layers at any time, although one submarine reported static balance obtained at 260 feet in February.

D. Acoustic conditions.

(1) Seasonal variation.

Echo-ranging conditions are usually *fair* throughout the area at all times of the year, except when the background-noise level is high. Assured echo ranges between 1,500 and 2,000 yards, therefore, may be expected away from the islands. Only rarely will heating of the surface layer produce *very bad* sound-ranging conditions with echo ranges of less than 750 yards. The maximum recorded range at which screw noises have been heard in this area is 10,000 yards, and pinging of surface vessels has been heard at a maximum range of 12,000 yards.

(2) Variation with depth.

On the rare occasions when there is diurnal surface heating or "afternoon effect," a submarine may be able to avoid detection by remaining at periscope depth, but usually it will be advantageous to dive to depths greater than 150 feet. Submarines in the area have reported that they were sometimes able to avoid detection by diving below the density layer at depths of 150 to 300 feet, but often no protecting layer will be found at any depth.

(3) Background noise.

The high noise level caused by reef-dwelling organisms is usually the limiting factor to sound-ranging near the islands and reefs. These reef noises may be troublesome to distances of 3 miles or more. Even in the open sea, fish noises are often prevalent, and rain squalls and high seas may drown out all other sounds. When the water is sufficiently deep for submarine operation near reefs, the high noise level and false echoes produced there will assist submarines in avoiding detection.

E. Transparency and color of water.

The degree of transparency determines the distance below the surface at which submarines and mines, as well as reefs and shoals, are visible from airplanes and surface craft. It also delimits the effectiveness of diving operations and the use of underwater cameras and telescopes for photographing and viewing wrecks, mines, submarine nets, etc. The color of the water may determine the most favorable type of paint to be used on vessels and mines.

(1) Transparency.

The degree of transparency is governed by the amount of suspended material in the water. The commonest method of measuring transparency is to record the average of the depths at which a white "Secchi disc" disappears and reappears when lowered and raised from a ship.

Only 8 transparency observations have been recorded for this area, all northeast of Mindanao. Of these observations, the minimum Secchi disc reading is 69 feet, the maximum is 141 feet, and the mean is 102 feet. Transparency decreases near land, owing to the disturbance of bottom sediments by waves

and currents, as well as to the amount of suspended material carried into the sea by rivers.

(2) Color.

The color of sea water is measured by comparing the color of the water, as seen against a white background, with a colorimetric scale known as Forel's Scale. This scale consists of a copper sulphate solution to which are added varying amounts of a solution of chrome yellow; pure copper sulphate solution is designated as Forel 0. On the spectrum, Forel 2 approximates Fraunhofer line F, and Forel 20 is near Fraunhofer line E. Eight color observations have been recorded for the area northeast of Mindanao; 5 of the observations record Forel 1, the remainder Forel 2. In shallow water near the islands and reefs the color of the water is modified by the color of the underlying bottom materials, and near river mouths color corresponding to Forel 5 or 6 may be encountered when there is considerable fresh-water runoff.

34. Bottom Sediments

Knowledge of the distribution of bottom sediments in water shallower than 100 fathoms is important in predicting underwater sound conditions, in mine warfare, and in planning landing operations.

A. Characteristics of sediment types.

The characteristics of the types of bottom sediments found on the narrow shelves bordering the Celebes Sea and adjacent waters in depths less than 100 fathoms are shown in TABLE III - 6.

TABLE III - 6

CHARACTERISTICS OF TYPES OF BOTTOM SEDIMENTS

TYPE OF BOTTOM	DESCRIPTION OF BOTTOM	PROBABLE ACOUSTIC EFFECTS OF BOTTOM	SUITABILITY FOR MINE FIELDS
Sand (including shells and washed gravel)	Firm, relatively smooth bottom	Long extension of range commonly obtained	Good
Sand and mud (including firm clay)	Relatively firm, smooth bottom	Moderate extension of range	Good
Mud	Soft, smooth bottom	Little extension possible; sound commonly absorbed	Poor; ground mines may sink in mud
Stone (predominantly cobbles and pebbles with varying amounts of mud and sand)	Hard bottom, commonly rough	Extension variable depending upon local conditions; reverberations may be strong	Poor
Rock (including bedrock outcrops and areas covered by boulders)	Rough broken bottom	Extension of range unlikely with either echo ranging or listening; strong reverberations tend to mask echoes	Poor; strong currents may be expected
Coral (with sandy patches)	Hard bottom, irregular to smooth	Extension variable depending upon local conditions; reverberations may be strong; noise level may be high owing to the presence of noisemaking reef animals	Poor

B. Horizontal distribution.

(1) Halmahera and adjacent islands.

On the open stretches of the shelf off Halmahera, off the smaller islands of the group, and in the straits between the smaller islands, the bottom sediments consist of alternating patches of *sand, coral,* and *stone.* The bottom is firm and for the most part texturally and topographically rough. The shallower bights and roadsteads, however, are apparently smoother and have somewhat more *sand* towards their heads, with fewer *coral* and *stone* areas. On the other hand, the larger bays, such as Dodinga (3), Boeli (24), Kaoe (27), and Waisile (29), and the partially enclosed bays have *mud* in the shallow water at their heads. This is probably of a sufficiently firm character to be classified as *sand and mud* for acoustic purposes. Fringing coral reefs are not found in the bays where *mud* is found close inshore. The approaches of these bays have rough *sand* and *coral* bottoms.

(2) Sangihe and Talaud Islands.

These islands and numerous others in the chain stretching south toward the northeastern part of Celebes have narrow, rough shelves of *sand, coral,* and *stone.* The numerous banks among the islands have similar sediments. The smaller, more protected bays sometimes have *mud* at their heads, but those which are open have *sand* and probably have smoother bottoms than the outlying shelf.

(3) Mindanao.

Along the southern coast of Mindanao, the shelf is relatively wide as far as Flecha Point (63), but narrows eastward. The bottom is *sand* or *coral* with occasional *rock* outcrops along the coast and patches of large *rock* and *coral* fragments offshore. The heads and more sheltered parts of the deep bays, such as Sibuguey (52), Port Sibulan (57), and Dumanquilas (58), are soft *mud.*

From Illana Bay (62) eastward to Davao Gulf (82), including Sarangani Bay (77), areas of *mud* appear with the *sand.* The *mud,* except off the larger rivers, such as the Mindanao (71), and in small protected bays, is firm and should be classified as *sand and mud* for acoustic purposes. *Coral* is poorly developed on this shelf, and reefs are absent.

In Davao Gulf (82) and off the east coast of Mindanao the shelf inside the 100-fathom curve is narrow, with *sand and mud, mud, sand, rock,* and *coral* patches irregularly distributed. The distribution of fringing reefs is also irregular. Around the northern shores of Davao Gulf (82), *mud and sand* extends close inshore, with a rough *sand, rock,* or *coral* bottom bordering the immediate shore line. The westerly side of the inner gulf has less *rock* and the fringing reefs are less developed than on the eastern side.

Northward from Cape San Agustin (92) past Pujuda (93) and Mayo (95) Bays to Cateel Bay (102), the narrow shelf is *sand,* with a few scattered *rock* patches and with fringing coral reefs along the shore. There is a little *mud* in Pujuda Bay (93) near shore. Between Cateel (102) and Lianga (108) Bays the shelf consists of *sand* and *rock* patches, but these bays and the smaller anchorages are mostly soft *mud,* with *sand* near the edges of the fringing reefs.

Bislig Bay (104) has *mud* at its head, in shoal water. North of Lianga Bay (108) to Siargao Island, *mud* is interspersed with sand, but the mud is probably firm and should therefore be classified as *sand and mud* for acoustic purposes. *Sand, rock,* and *coral* are found in the shallow water near shore. There are occasional stretches of *sand* along the shore line, as near the mouth of the Tago River (109) and at the head of Lanuza Bay (112),

where the bottom immediately offshore is also sandy. The central part of the larger eastern portion of Hinatuan Passage, west of Bucas Grande Island (115), is soft *mud*, but the narrower western extension between Nonoc Island (131) and Mindanao has a firm *sand* bottom. Dinagat Sound (123) has a *sand* bottom with scattered reefs.

Along the northwestern and western coasts of Mindanao, including Butuan (145), Gingoog (149), Macajalar (154), and Iligan (157) Bays, the shelf is also narrow, in places less than a mile wide. In general, there is more *mud* than along the eastern coast, although occasional patches of *sand* and *rock* occur; there is little fringing reef. Around Camiguin Island (151), the shelf is sandy.

On the western side of Iligan Bay (157) and along the western side of Mindanao as far as Zamboanga (176), the shelf is largely *sand* and *rock* with occasional stretches, noted on the charts as *mud*, which are probably *sand and mud*, e.g., in Sindangan Bay (168). Fringing reefs are developed locally.

(4) Sulu Archipelago.

The bottom of the shallow sill surrounding the numerous islands and coral reefs of the Sulu Archipelago is *sand* and *coral* with occasional notations on the charts of *rock*. Except along the coasts, *rock* probably does not indicate ledges but rather large fragments of *coral* or *rock* detritus. Near the islands the bottom is rough and broken with numerous reefs, but away from the islands, particularly to the northeast, there are large areas of relatively smooth *sand* bottom and *coral* fragments.

(5) Northern Borneo.

Along the west coast of Borneo between Brunei (288) and Kimanis (291) Bays, reefs and banks of *coral* occur over the entire width of the shelf, interspersed with *sand* and *sand and mud*. However, few fringing reefs are present. Both bays have *mud* with *sand and mud* near the shore.

North of Kimanis Bay (291) to Sampanmangio Point (299), the outer part of the shelf near the 100-fathom curve is broken by numerous coral reefs and shoals, with *mud* in the deeper water between them. The central part of the shelf is *mud* and fairly level. *Mud* bottom, probably mixed with *sand*, extends to the shore, with scattered *coral* in shoal water and a fringing reef along the shore. The reef becomes more extensive and less patchy toward the north.

Off the northern tip of Borneo the shelf broadens; the bottom is rough and broken and consists of *sand*, *coral* fragments, and *stone*. However, *mud* extends across the shelf west of Banguey (304) and Balambangan (302) Islands and some is found in the channels between Banguey (304) and the smaller islands, and the mainland. The *mud*, which is probably mixed with *sand* and therefore is not soft, extends into Marudu Bay (300) where the bottom is soft *mud*.

Southward along the northeast coast to Sandakan Harbor (316), the shelf is about 60 miles wide with a bottom principally of *sand and mud*, interspersed with *coral* patches and reefs, which are particularly numerous on the inner half of the shelf and produce a rough, broken bottom. The outer part of the shelf is fairly level, with areas of *sand and mud* stretching for miles, uninterrupted by reefs. The large bays, such as Paitan (309), Marches (310), Labuk (311), and Sandakan Harbor (316), have fairly soft *mud* bottoms with *sand and mud* between the reefs off their entrances.

From Sandakan Harbor (316) to Unsang Point (319) the shelf is *mud*, probably containing considerable *sand*, except for scattered coral reefs; *sand* and *coral* occur near the 100-fathom curve. There is no fringing reef along the shore.

Darvel Bay (322) has a *mud* bottom, probably soft, and the shores are partly bordered by fringing reefs and *mud* (FIGURE III - 11). The shelf between Darvel Bay (322) and the vicinity of Bum Bum Island (327) is *sand* and *coral*. Westward to Sibuko Bay (332) the shelf is *mud* but is bordered along the 100-fathom curve by a *sand* and *coral* bottom and coral reefs.

From Cowie Harbor (337) south to the delta of the Boeloengan River (357), there is no fringing reef and no *coral* on the outer part of the shelf. The shore line and the inner part of the shelf are made up of a series of confluent deltas of several large rivers. The inner parts of the deeper estuaries, such as Cowie Harbor (337), are almost entirely soft *mud*, but the delta of the Boeloengan (357) is somewhat sandy. The sediments near the 100-fathom curve are apt to be somewhat sandier than near the river mouths.

Off the delta of the Boeloengan River (357), *mud* (probably *sand and mud*) occupies most of the shelf from the shore seaward, with *sand* and a few scattered patches of *coral* near the 100-fathom curve. Southward to the Beraoe River (367) estuary, coral reefs are extensively developed and occupy the full width of the shelf. Between the mouth of the Beraoe River (367) and Mangkalihat Point (373) is an extensive platform of rough *coral* bottom and *sand* dotted with numerous reefs, in one place extending about 27 miles offshore; *mud*, which should probably be classified as *sand and mud*, is restricted to the immediate shore line. Between the reefs and the delta of the Beraoe River (367) the shelf is flat and the bottom is all *sand*. The inshore part of the delta is somewhat sandy, and should probably be classified as *sand and mud*, but the outer parts are soft *mud*. Coral reefs are restricted to the vicinity of the 100-fathom curve and do not occur along the shores of this estuary. Two large coral platforms, Maratoea (361) and Moeras (364) Reefs, occur some distance offshore.

From Mangkalihat Point (373) south to the equator, fringing reefs and *sand* are found along the shore. The central part of the shelf is *mud*, probably largely *sand and mud*, with *coral* bottom and a few scattered reefs occurring in the vicinity of the 100-fathom curve. However, *coral* is absent off the mouth of the Sangkoelirang River (374) and for roughly 20 miles to the east, and soft river *mud* covers the bottom of the estuary and the whole width of the shelf.

(6) Northern Celebes.

From the equator northeast to Dondo Bay (381), the shelf is narrow off the headlands but widens off the broad reentrants. The bottom is rough *sand* and *coral* with numerous coral reefs. *Mud* bottom is restricted to the small, sheltered bays along the shore. From Dondo Bay (381) to Stroomen-kaap (388) the bottom characteristics are the same but the shelf broadens.

From Stroomen-kaap (388) to Kandi Point (389), *sand*, *coral*, and *stone* bottom occupies the full width of the narrow shelf. The shelf becomes muddier and widens to about 13 miles off Koeandang-baai (390). The bottom of the inner parts of the bay are covered with soft *mud*. Along this whole stretch of coast where muddy sediments are found close inshore, *coral* is restricted to the outer part of the shelf and the shore line is largely free of fringing reefs.

Between Koeandang-baai (390) and Bolaängoeki Bay (392), the shelf is wide, and the shoal water bottom near shore is largely *mud* and *sand and mud*. *Sand*, *coral*, and *stone* are not

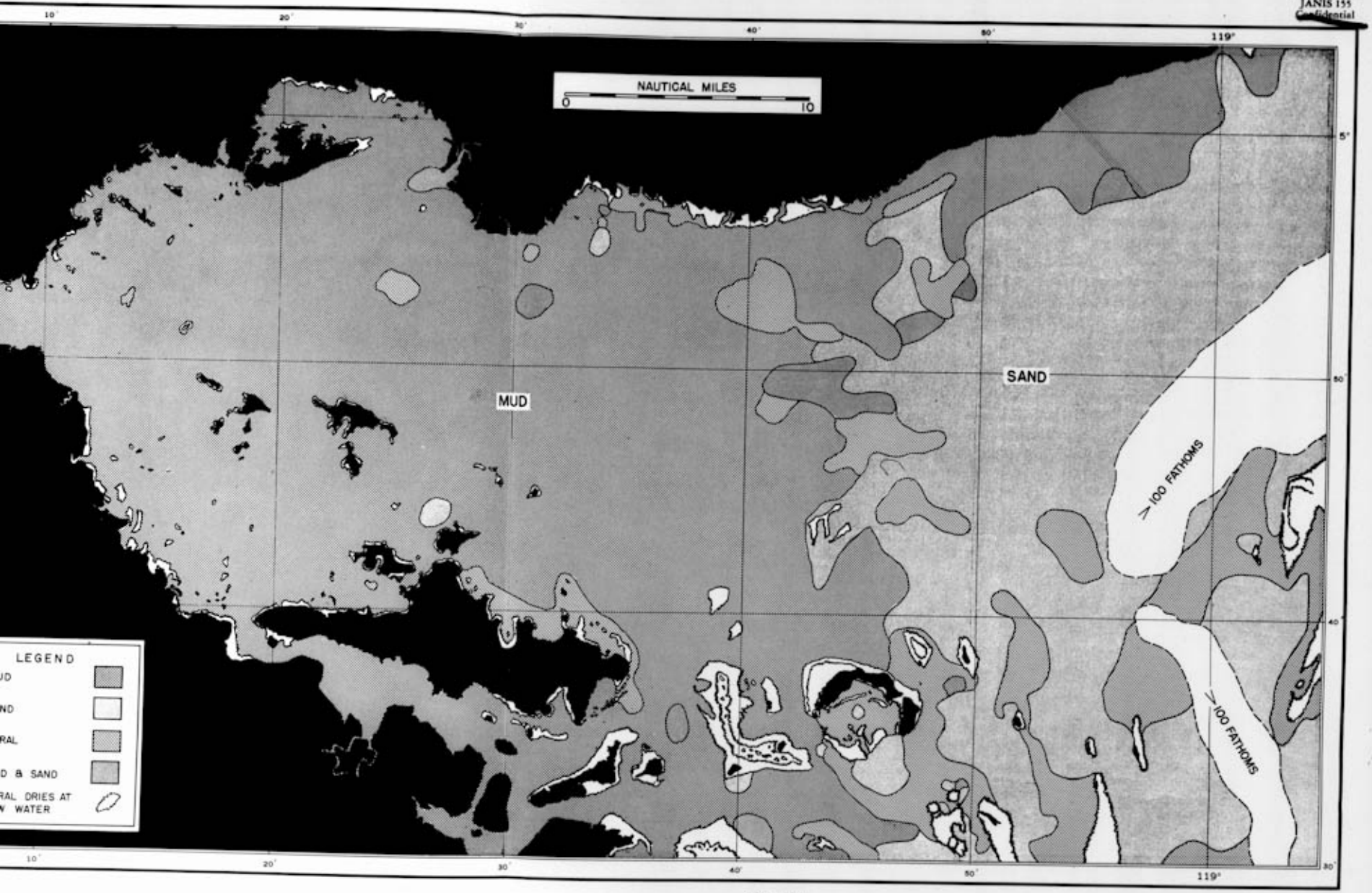

FIGURE III - 11.
Bottom sediments, Darvel Bay, east coast of Borneo.

entirely absent, but hard bottoms are more often restricted to the vicinity of the 100-fathom curve. Along the northern coast east of Bolaängoeki Bay (392), the shelf narrows and consists of *sand, coral,* and patches of *stone.* There is a fringing reef along the shore. Soft *mud* is found in the numerous small, sheltered bays, such as Himana (391), Bolaängoeki (392), and Kora Kora (395).

The shelf bordering the southern coast of northeastern Celebes is very similar to that surrounding Halmahera. It is narrow and consists largely of patches of *sand, coral,* and *stone.* The shore line is occasionally broken by shallow bays and roadsteads, such as Kema (404), Belang (406), and Kotaboena (407) Roads, which are somewhat smoother and sandier than the intervening stretches of shelf. Along the north shore of Tomini Gulf, *sand and mud* also occurs on the central part of the shelf although *sand, coral,* and *stone* are still present. The small, protected bays have *mud.* Offshore, in the vicinity of the 100-fathom curve, coral reefs are well developed. Fringing reefs border the shore line except for a stretch of 20 miles to the west of the Gorontalo River (408), where they are apparently not well developed.

35. *Biological Factors*

A. Algae (seaweeds).

Large seaweeds which may interfere with landing operations do not occur in this area.

B. Bioluminescence ("phosphorescence").

Night detection or concealment of PT boats, submarines, and other craft are seriously affected by the luminescence of their wakes and bow waves, owing to small light-producing organisms in the sea. Although there are few direct observations on the occurrence of bioluminescence in this area, a comparison with other areas where similar light-producing organisms are found indicates that bioluminescence probably occurs throughout the area during each month of the year, with the maximum frequency in August. Brilliant bioluminescence usually occurs after periods of unusually fine weather. Elsewhere, luminescence under similar conditions has been reported by fliers to interfere with dark adaptation.

TABLE III - 7

TIDAL DIFFERENCES AND CONSTANTS

PLACE	LAT. ° ′	LONG. ° ′	Tidal Differences: Times: TIME OF HW & LW H.M.	Heights: RATIO FOR HW & LW	Heights: CORRECTION FOR DATUM FT.	Ranges: SPRING FT.	Ranges: MEAN FT.	MSL FT.
	N	E	Time Meridian 127° 30′ E					
HALMAHERA								
			Reference station, KOETAI RIVER ENTRANCE					
Ternate I. (1)								
Ternate (2)	0 47	127 23	+0 15	0.5	+0.7	3.3	2.2	3.0
	S	E	Reference station, JOLO			TROPIC	MEAN DIURNAL	
Batjan I. (4)								
Waisabatang (5)	0 26	127 39	−2 50	1.0	+1.2	2.8	2.7	2.3
Laboeha (6)	0 38	127 28	−4 40	0.6	+1.3	2.1	1.6	2.0
Gane Bay (13)	0 45	128 13	−3 25	0.9	+1.3	2.6	2.4	2.3
	N	E	Reference station, SANDAKAN			SPRING	MEAN	
Gamsoengi (18)	0 17	128 46	−6 10	0.4	+1.2	1.9	1.3	2.6
			Reference station, PENANG					
Tepelea (22)	0 19	128 45	−7 50	0.6	+0.1	3.5	2.6	2.6
Bitjoli (23)	0 35	128 31	−7 35	0.8	−0.6	4.2	3.1	3.0
Boeli-serani (25)	0 54	128 18	−7 20	0.8	−0.6	4.4	3.4	3.0
Kaoe (28)	1 10	127 54	−6 10	1.0	−0.6	5.5	4.1	3.9
Galela Bay (33)	1 48	127 53	−7 20	0.7	+0.4	4.3	3.0	3.6
Asimiro (37)	2 00	127 46	−7 10	0.7	+0.4	3.9	2.9	3.6
ISLANDS SOUTH OF MINDANAO								
			Time Meridian 120° E					
Talaud Is.								
Liroeng Road (39)	3 56	126 42	−8 05	0.8	−0.3	5.0	3.4	3.3
			Reference station, KOETAI RIVER ENTRANCE					
Sangihe I. (43)								
Manaloe (46)	3 31	125 38	−0 10	0.9	+0.2	6.1	4.2	4.3
Tahoena (44)	3 37	125 29	−0 15	0.8	+0.2	5.7	3.9	3.9

TABLE III - 7 (cont.)

TIDAL DIFFERENCES AND CONSTANTS

PLACE	LAT. ° ′	LONG. ° ′	Tidal Differences: Times: TIME OF HW & LW H.M.	Heights: RATIO FOR HW & LW	Heights: CORRECTION FOR DATUM FT.	Ranges: MEAN DIURNAL FT.	Ranges: MEAN FT.	Ranges: MSL FT.
MINDANAO ISLAND			Time Meridian 120° E					
			Reference station, DAVAO					
Sibuguey Bay (52)								
Port Banga (53)	7 31	122 25	+0 20	1.2	−0.3	5.9	5.0	2.8
Ticauan Point (54)	7 45	122 44	+0 20	1.2	−0.2	6.1	5.2	2.9
Taba Bay (55)	7 35	122 47	+0 20	1.2	−0.3	6.0	5.1	2.8
Port Sibulan (57)	7 26	122 53	+0 15	1.1	−0.1	5.8	4.9	2.8
Dumanquilas Bay (58)								
Margosatubig (59)	7 35	123 10	+0 10	1.1	−0.4	5.3	4.6	2.5
Maligay Bay (60)	7 32	123 15	+0 15	1.1	−0.2	5.6	4.8	2.7
Illana Bay (62)								
Limbug Cove (64)	7 28	123 24	+0 15	1.1	−0.3	5.5	4.7	2.6
Port Sambulauan (65)	7 32	123 24	+0 15	1.1	−0.2	5.6	4.8	2.7
Pagadian (66)	7 49	123 27	+0 15	1.1	−0.1	5.7	4.9	2.8
Tucuran (67)	7 51	123 35	+0 15	1.1	−0.2	5.6	4.8	2.7
Port Baras (69)	7 38	124 01	+0 10	1.1	−0.2	5.6	4.8	2.7
Polloc Harbor (70)	7 21	124 13	+0 10	1.1	−0.3	5.6	4.8	2.6
Mindanao R. (71)								
Cotabato (72)	7 13	124 15	+1 20	0.7	−0.2	3.5	3.0	1.6
Port Lebak (74)	6 32	124 03	+0 05	1.2	−0.3	5.8	5.0	2.8
Sarangani Bay (77)	5 50	125 12	0 00	1.0	0.0	5.3	4.5	2.6
Sarangani I. (80)	5 25	125 26	0 00	1.0	−0.2	5.2	4.3	2.4
Davao Gulf (82)								
Malita (85)	6 25	125 37	−0 10	1.0	0.0	5.1	4.1	2.6
Bolton Malalag (86)	6 36	125 25	0 00	1.0	−0.2	4.9	4.1	2.4
DAVAO (87)	7 05	125 38		(See predictions.)		5.1	4.3	2.6
Sigaboy I. (90)	6 38	126 04	0 00	1.0	−0.1	5.0	4.2	2.5
Lavigan Anchorage (91)	6 18	126 11	0 00	1.0	−0.2	4.9	4.1	2.4
Pujada Bay (93)								
Mati (94)	6 57	126 13	0 00	0.9	+0.2	4.8	4.0	2.5
Caraga Bay (98)	7 17	126 35	0 00	1.0	0.0	5.0	4.1	2.6
Hinatuan (106)	8 22	126 20	+0 05	0.9	+0.3	4.9	4.0	2.6
Tandag (110)	9 05	126 12	+0 05	0.9	+0.3	4.7	3.9	2.6
General I.								
Buenavista (113)	9 25	126 00	+0 10	0.9	+0.2	4.6	3.8	2.5
Tugas Point (114)	9 29	125 57	+0 10	0.9	+0.2	4.6	3.8	2.5
Bucas Grande I. (115)								
Sohutan Bay (116)	9 36	125 55	+0 20	0.9	+0.2	4.6	3.8	2.5
East Bucas I.								
San Miguel (118)	9 44	126 02	+0 20	0.7	+0.4	4.1	3.2	2.2
Siargao I.								
Port Pilar (119)	9 52	126 06	+0 15	0.7	+0.3	4.0	3.2	2.1
Kangbangyo I.								
Tayanan (122)	9 54	125 54	+0 25	0.9	+0.1	4.4	3.7	2.4
Talavera I.								
Cuyomongan (124)	9 45	125 41	+0 30	0.9	+0.2	4.6	3.8	2.5
Dinagat I. (132)								
Gaas Bay (135)	10 11	125 39	+0 30	0.7	+0.4	4.0	3.2	2.2
Malinao Inlet (136)	10 15	125 38	+0 30	0.7	+0.4	4.0	3.2	2.2
			Reference station, MANILA					
Dinagat I. (132)								
Puerto Princesa (141)	10 06	125 29	−0 20	1.1	0.0	3.5	—	1.8
Melgar (142)	10 04	125 31	0 00	1.0	+0.1	3.4	—	1.7
Dinagat (143)	9 58	125 35	+0 20	1.0	+0.1	3.4	—	1.7
Surigao (144)	9 48	125 29	+0 45	1.0	+0.1	3.4	—	1.7
			Reference station, CEBU					
Butuan Bay (145)								
Agusan R. entrance (146)	9 00	125 31	−0 10	0.8	−0.2	3.8	2.5	1.6
Nasipit Harbor (148)	8 59	125 20	−0 15	0.8	+0.1	4.1	2.8	1.9
Canausayor Anchorage (150)	9 00	124 51	−0 15	0.8	0.0	4.1	2.6	1.8
Camiguin I. (151)								
Mambajao (152)	9 15	124 43	−0 15	0.8	0.0	4.1	2.5	1.8
Macajalar Bay (154)								
Macabalan Point (156)	8 30	124 40	−0 15	0.8	0.0	4.2	2.7	1.8
Iligan Bay (157)								
Iligan (158)	8 14	124 14	−0 10	0.8	+0.2	4.2	2.6	2.0
Misamis (159)	8 09	123 51	0 00	0.9	−0.1	4.4	2.9	2.0
Jimenez (160)	8 20	123 51	−0 05	0.8	0.0	4.1	2.7	1.8
Oroquieta (161)	8 29	123 48	−0 15	0.8	0.0	4.0	2.7	1.8
Plaridel (162)	8 37	123 45	−0 25	0.8	+0.1	4.1	2.6	1.9
Murcielagos Bay (163)	8 38	123 34	−0 10	0.8	+0.2	4.2	2.8	2.0
Dapitan (165)	8 40	123 25	−0 40	0.8	+0.1	4.4	2.6	1.9
Puerto Santa Maria (171)	7 46	122 07	−0 40	0.8	0.0	4.2	2.5	1.8
Panabutan Bay (172)	7 35	122 08	−0 40	0.8	0.0	4.1	2.5	1.8
Sibuco Bay (173)	7 19	122 04	−0 40	0.8	0.0	4.0	2.5	1.8
			Reference station, JOLO					
Zamboanga (176)	6 54	122 04	−1 55	1.2	+0.1	3.3	2.3	1.4
Sacol I.								
Landang (180)	6 57	122 15	−2 25	1.6	+0.2	4.6	3.8	2.0

TABLE III - 7 (cont.)

PLACE	LAT. ° ′	LONG. ° ′	Times: TIME OF HW & LW H.M.	Heights: RATIO OF HW & LW	Heights: CORRECTION FOR DATUM FT.	Heights: MEAN DIURNAL FT.	Ranges: MEAN FT.	Ranges: MSL FT.
SULU ISLANDS	N	E	Time Meridian 120° E					
			Reference station, JOLO					
Dassalan I. (181)	6 44	121 28	+0 20	1.2	+0.3	3.3	—	1.6
Basilan I.								
Isabela (186)	6 42	121 58	0 00	0.8	+0.2	2.2	—	1.1
Port Holland (191)	6 33	121 52	−1 50	1.1	+0.1	3.0	2.2	1.3
			Reference station, CEBU					
Amaloy (196)	6 26	122 08	−5 10	1.6	−0.9	6.2	5.4	2.8
Bohelebong (197)	6 31	122 12	−5 35	1.4	−0.6	5.2	4.5	2.6
Balas (198)	6 41	122 08	−5 15	1.1	−0.5	4.3	3.6	2.0
Linawan I. (202)	6 19	121 56	−5 50	1.1	−0.7	4.1	3.5	1.8
Bulan I. (207)	6 09	121 50	−5 33	1.2	−0.6	4.7	4.0	2.2
Simisa I. (209)	5 58	121 34	−5 35	1.1	−0.6	4.2	3.5	1.9
Capual I. (210)	6 01	121 25	−5 25	1.2	−0.7	4.9	3.9	2.1
			Reference station, JOLO					
Tulayan I. (213)	6 01	121 19	−1 55	0.9	+0.2	2.4	—	1.2
Jolo I.								
JOLO (214)	6 04	121 00	(See predictions.)			2.8	—	1.1
			Reference station, CEBU					
Maimbung (216)	5 55	121 01	−5 15	1.0	−0.6	3.9	3.2	1.7
Tapul I. (220)	5 42	120 53	−5 00	0.6	−0.2	2.7	2.0	1.2
			Reference station, JOLO					
Siasi I. (222)								
Siasi (223)	5 33	120 49	−1 35	1.5	+0.4	4.1	—	2.0
Pearl Bank (235)	5 51	119 44	+1 10	1.2	+0.4	3.4	—	1.7
Lahatlahat I. (237)	5 39	120 17	−0 35	0.9	+0.3	2.6	—	1.3
Tawitawi Is.								
Tataan Pass (277)	5 15	119 57	−0 30	0.9	+0.2	2.4	—	1.2
Basbas Channel (238)	5 21	120 13	−0 40	0.9	+0.2	2.5	—	1.2
			Reference station, CEBU					
Tandungan Channel (249)	5 13	120 19	−5 10	1.0	−0.3	4.4	3.4	2.0
Gallo Malo Channel (257)	5 08	120 14	−5 05	1.5	−0.6	5.9	5.1	2.8
Banaran I. (259)	5 02	120 06	−5 30	1.5	−0.8	5.6	4.8	2.6
Batu Batu Bay (267)	5 04	119 53	−5 35	1.0	−0.3	4.4	3.4	2.0
Port Bongao (269)	5 02	119 46	−5 20	1.0	−0.5	4.2	3.3	1.8
Siboru I. (279)	4 45	119 30	−4 55	1.1	−0.3	5.0	3.5	2.2
Tumindao I. (281)	4 47	119 25	−5 20	0.9	−0.5	3.8	3.1	1.6
BORNEO							MEAN DIURNAL	
			Reference station, MANILA			TROPIC		
Mengalum I. (294)	6 12	115 36	+0 20	1.2	+1.6	5.1	4.0	3.5
Jesselton (295)	5 59	116 04	+0 20	1.2	+1.4	5.2	4.1	3.3
Kudat, Marudu Bay (301)	6 53	116 51	+0 10	1.3	+2.9	5.6	4.5	5.0
			Reference station, SANDAKAN			SPRING	MEAN	
Marchesa Bay (310)	6 32	117 35	−0 05	0.9	+1.0	3.6	2.8	4.2
SANDAKAN (315)	5 50	118 07	(See predictions.)			4.0	3.1	3.6
Dent Haven (320)	5 16	119 15	−4 40	0.8	+0.1	3.2	2.5	3.0
			Reference station, KOETAI RIVER ENTRANCE					
Darvel Bay (322)								
Lahad Datu (323)	5 02	118 20	0 00	0.8	−0.5	5.0	3.8	3.2
Semporna (324)	4 29	118 37	+0 05	0.8	−0.5	5.2	3.8	3.2
Tawau* (336)	4 15	117 53	+0 20	1.2	−0.5	8.0	5.7	5.0
			Time Meridian 112° 30′ E					
			Reference station, KOETAI RIVER ENTRANCE					
Boenjoe or Tanahmerah I. (350)	3 30	117 48	+0 55	1.0	+1.0	6.6	4.8	5.6
Tarakan, Tarakan I. (352)	3 17	117 35	−0 50	1.4	−0.8	9.3	6.5	5.6
Boeloengan R. (357)								
Biwan Mouth (358)	2 55	117 42	0 00	1.3	−0.1	8.7	6.0	5.9
Selor Pt. (360)	2 49	117 22	+2 10	0.5	−0.3	3.4	2.4	2.0
Beraoe R. (367)								
Kassaimouth (368)	2 10	117 52	−0 05	1.3	−0.1	9.1	6.3	5.9
Haji Bank (369)	2 11	117 32	+1 50	1.1	−1.2	7.4	5.3	3.9
Sangkoelirang R. entrance (374)								
Sangkoelirang (375)	0 59	117 59	−0 15	1.2	−1.6	8.4	5.6	3.9
Miang-besar (376)	0 45	118 00	−0 40	0.9	+0.2	5.8	4.0	4.3
			Time Meridian 120° E					
CELEBES								
Tolitoli-baai (385)	1 02	120 49	−0 05	0.7	+0.7	5.2	3.4	3.9
Manado (393)	1 30	124 50	+0 10	0.9	−0.2	6.1	4.2	3.9
			Reference station, PENANG					
Talise I. (398)	1 50	125 05	−6 50	1.0	−0.6	6.0	4.2	3.9
			Reference station, JOLO			TROPIC	MEAN DIURNAL	
Kema (404)	1 22	125 05	−3 00	0.8	+3.0	2.5	2.2	3.9
Gorontalo R. entrance (408)	0 30	123 03	−3 55	0.8	+1.7	2.7	2.2	2.6
Maninili (409)	0 03	120 06	−3 40	1.0	+1.5	3.0	2.9	2.6

*The Siboekoe River (347), which empties into the southwestern part of Sibuko Bay (332), is reported to have a bore above the village of Pangeran Anan (not located on chart). It occurs shortly after low water from about 3 days before to 3 days after spring tides.

TABLE III - 8a DAILY TIDE PREDICTIONS

JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER					NOVEMBER					DECEMBER				
Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low	
	Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.
	h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.
1	3 40	5.1	8 47	4.7	1	2 17	5.0	8 46	3.8	1	3 40	5.5	10 54	2.4	1	5 04	5.6	11 41	0.9	1	5 20	7.4	11 20	0.8	1	5 57	7.8	0 03	1.2	1	6 10	7.3	0 27	1.8
Th	14 02	5.5	21 03	3.3	Sa	13 25	4.4	20 10	2.5	Tu	15 53	5.5	21 30	1.8	F	17 28	5.1	23 14	0.8	Su	17 41	7.0	23 43	0.7	M	18 15	9.2	11 59	0.9	F	18 30	9.8	12 01	1.7
2	3 52	5.9	9 53	4.0	2	3 23	5.7	10 05	3.1	2	4 31	6.2	11 27	1.7	2	5 39	7.3	12 08	0.4	2	5 51	7.6	. . .	. .	2	6 38	7.7	0 36	1.0	2	6 42	7.1	1 03	1.9
F	15 17	5.6	21 37	2.8	Su	15 07	4.4	21 06	2.2	M	16 51	4.1	22 28	1.3	Sa	17 58	5.8	23 52	0.2	M	18 08	7.7	12 04	0.4	Tu	19 05	9.4	12 26	1.0	Sa	19 01	9.7	12 29	1.8
3	4 11	5.6	10 31	3.3	3	4 07	6.4	10 50	2.5	3	5 12	6.9	11 56	1.0	3	6 11	7.7	. . .	. .	3	6 22	7.9	0 16	0.3	3	6 58	7.4	1 09	1.1	3	7 14	6.8	1 36	2.1
Sa	16 01	5.9	22 05	2.4	M	16 05	4.5	21 55	1.8	Th	17 31	4.6	23 13	0.7	Su	18 29	6.4	12 25	0.0	Tu	18 38	8.1	12 30	0.1	W	19 38	9.5	12 52	1.1	Su	19 32	9.5	12 57	2.1
4	4 37	7.4	11 03	2.7	4	4 43	7.1	11 25	2.0	4	5 49	7.4	12 27	0.5	4	6 42	7.9	0 27	-0.2	4	6 52	7.8	0 49	0.1	4	7 25	7.0	1 42	1.4	4	7 44	6.5	2 13	2.4
Su	16 37	6.1	22 32	2.0	Tu	16 50	4.8	22 36	1.3	F	18 06	5.1	23 52	0.3	M	18 58	6.8	13 02	-0.3	W	19 08	8.4	12 56	0.1	Th	20 13	9.5	13 17	1.5	M	20 03	9.0	13 24	2.5
5	5 05	8.0	11 35	2.2	5	5 19	7.7	12 00	1.4	5	6 23	7.9	. .	. .	5	7 13	7.8	1 01	-0.4	5	7 18	7.5	1 20	0.2	5	7 54	6.5	2 16	1.9	5	8 19	6.1	2 49	2.8
M	17 12	6.7	23 00	1.6	W	17 31	5.1	23 15	1.0	Sa	18 41	5.6	12 57	0.1	Tu	19 30	7.1	13 29	-0.4	Th	19 35	8.4	13 22	0.3	Sa	20 13	8.6	13 40	1.8	Tu	20 35	8.5	13 51	3.0
6	5 33	8.6	12 05	1.8	6	5 53	8.1	12 32	1.0	6	6 56	8.0	0 21	0.0	6	7 42	7.5	1 33	-0.3	6	7 46	7.0	1 52	0.6	6	8 30	5.9	2 50	2.5	6	8 55	5.7	3 28	3.2
Tu	17 40	6.3	23 29	1.3	Th	18 07	5.4	23 53	0.7	Su	19 13	5.9	13 27	-0.1	W	19 59	7.1	13 55	-0.2	F	20 04	6.2	13 46	0.6	Su	20 45	7.9	14 01	2.5	M	21 30	7.8	14 17	3.5
7	6 02	9.0	. .	. .	7	6 27	8.4	. .	. .	7	7 28	7.9	1 07	-0.2	7	8 11	7.0	2 07	0.0	7	8 12	6.4	2 24	1.1	7	8 46	5.3	3 32	3.2	7	9 44	5.2	4 14	3.7
W	18 11	6.4	12 26	1.5	F	18 43	5.6	13 06	0.7	M	19 48	6.1	13 57	-0.2	Th	20 21	7.0	14 22	0.1	Sa	20 33	7.7	14 09	1.1	M	21 27	7.2	14 38	3.2	Tu	21 49	7.1	14 45	4.1
8	6 34	9.2	0 00	1.1	8	7 02	8.4	0 20	0.5	8	8 02	7.6	1 44	-0.1	8	8 36	6.3	2 39	0.6	8	8 38	5.7	2 57	1.8	8	9 18	4.7	4 27	3.8	8	11 29	5.2	5 17	4.0
Th	18 44	6.3	13 09	1.4	Sa	19 20	5.7	13 39	0.6	Tu	20 24	6.1	14 27	-0.1	F	21 04	6.6	14 46	0.5	Su	21 05	7.0	14 30	1.7	Tu	22 03	6.4	14 52	3.8	W	22 45	6.4	15 30	4.8
9	7 06	9.1	0 32	1.1	9	7 37	8.3	1 07	0.5	9	8 55	7.1	2 20	0.2	9	9 07	5.5	3 15	1.5	9	9 00	4.8	3 25	2.7	9	. . .	. .	5 04	4.2	9	. . .	. .	7 03	4.2
F	19 19	6.2	13 43	1.4	Su	19 57	5.7	14 16	0.6	W	21 00	6.0	14 57	0.1	Sa	21 41	6.1	15 12	1.1	M	21 41	6.3	14 45	2.5	Th	. . .	. .	14 43	5.3	Su	14 43	5.3	19 17	5.3
10	7 40	8.9	1 06	1.2	10	8 12	8.0	1 45	0.7	10	9 07	6.4	2 58	0.7	10	9 30	4.7	3 55	2.2	10	9 05	4.2	4 28	3.5	10	0 40	5.8	9 26	3.7	10	1 02	6.0	6 22	4.0
Su	19 56	6.0	14 21	1.6	M	20 36	5.6	14 50	0.7	Th	21 41	5.7	15 29	0.5	Su	22 25	5.4	15 36	1.8	Tu	22 33	5.5	14 42	3.1	F	16 27	5.4	21 28	4.7	Su	15 29	6.2	21 29	4.8
11	8 17	8.5	1 41	1.5	11	8 52	7.6	2 24	1.0	11	9 40	5.6	3 36	1.4	11	9 52	3.8	5 00	3.0	11	. . .	. .	11 42	3.5	11	1 06	6.0	10 00	3.3	11	2 45	5.9	8 19	3.6
M	20 40	5.7	15 02	1.8	Tu	21 23	5.4	15 28	0.9	F	22 20	5.3	16 03	1.0	M	. .	. .	15 56	2.5	W	. .	. .	. .	. .	Sa	16 30	6.1	22 16	4.0	M	15 57	7.0	22 19	4.2
12	9 00	7.8	2 20	2.0	12	9 32	6.7	3 06	1.6	12	10 21	4.7	4 29	2.2	12	0 07	4.8	. .	. .	12	2 50	5.3	10 47	2.9	12	3 54	6.4	10 30	2.9	12	3 46	6.1	9 42	3.2
Tu	21 34	5.3	15 48	2.2	W	22 18	5.2	16 11	1.2	Sa	22 38	4.9	16 41	1.6	Tu	. .	. .	12 45	3.0	Th	17 13	4.8	22 04	3.8	Su	16 41	6.8	22 46	3.4	Tu	16 27	7.7	22 56	3.7
13	9 48	7.1	3 08	2.7	13	10 18	5.9	4 01	2.2	13	11 10	3.8	6 00	2.9	13	3 36	5.1	11 15	2.3	13	4 08	6.0	10 57	2.4	13	4 29	6.7	10 39	2.6	13	4 22	6.3	10 14	2.9
W	22 50	5.0	16 48	2.5	Th	23 26	5.0	17 01	1.6	Su	. .	. .	17 45	2.1	W	17 11	3.9	21 58	2.9	F	17 08	5.4	22 39	3.1	M	16 59	7.5	23 14	2.9	W	15 53	8.4	23 25	3.2
14	10 51	6.3	4 14	3.4	14	11 17	5.1	5 15	2.9	14	1 45	4.8	7 56	2.9	14	4 31	5.8	11 31	1.7	14	4 40	6.5	11 11	2.0	14	5 00	6.9	11 00	2.2	14	4 57	6.2	10 44	2.6
Th	. .	. .	18 05	2.7	F	. .	. .	18 04	2.0	M	14 15	3.1	20 05	2.4	Th	17 34	4.5	22 47	2.2	Sa	17 17	6.1	23 06	2.4	Tu	17 21	8.2	23 41	2.4	Th	17 22	9.0	23 56	2.8
15	0 42	5.1	6 17	3.8	15	1 04	5.0	7 27	3.2	15	3 43	5.3	11 06	2.2	15	5 07	6.4	11 49	1.3	15	5 06	6.9	11 26	1.7	15	5 35	7.0	11 20	1.9	15	5 39	6.6	11 15	2.3
Th	12 26	5.7	19 35	2.6	Sa	12 53	4.4	19 21	2.1	Tu	15 30	3.5	21 47	2.1	F	17 40	5.2	23 21	1.6	Su	17 32	6.8	23 34	1.9	W	17 42	8.8	. .	. .	F	17 52	9.4	. .	. .
16	2 25	5.7	8 30	3.6	16	2 45	5.4	9 32	2.9	16	4 40	5.9	11 40	1.5	16	5 35	6.9	12 05	0.9	16	5 34	7.2	11 44	1.4	16	5 50	7.1	0 07	2.0	16	6 00	6.8	0 27	2.5
F	14 09	5.5	20 45	2.3	Su	14 45	4.1	20 52	2.0	W	17 19	4.0	22 43	1.7	Sa	18 00	5.7	23 50	1.1	Tu	17 50	7.4	23 56	1.4	Th	18 07	9.2	11 42	1.7	Sa	18 23	9.7	11 45	2.0
17	3 27	6.4	9 48	3.0	17	3 53	6.1	10 44	2.2	Th	5 19	6.5	12 07	1.0	17	6 00	7.2	. .	. .	17	6 55	7.3	. .	. .	F	6 16	7.1	0 35	1.9	17	6 32	6.9	0 59	2.2
Sa	15 23	5.5	21 34	1.9	M	16 05	4.2	21 51	1.7	Th	17 49	4.5	23 22	1.2	Su	18 19	6.3	12 23	0.6	M	18 10	7.9	12 00	1.2	Sa	18 34	9.5	12 06	1.6	Su	18 53	9.8	12 19	1.9
18	4 15	7.1	10 42	2.4	18	4 41	6.8	11 31	1.6	F	5 50	7.0	12 30	0.6	18	6 25	7.9	0 15	0.7	18	8 18	7.3	0 20	1.2	Su	6 43	7.0	1 04	1.8	M	7 06	6.9	1 32	2.2
Su	16 20	5.7	22 17	1.6	Tu	17 00	4.4	22 39	1.4	F	18 14	4.9	23 54	0.7	M	18 39	6.7	12 44	0.5	Tu	18 32	8.4	12 18	1.0	M	19 02	9.6	12 32	1.5	Tu	19 27	9.7	12 52	2.0
19	4 55	7.7	11 26	1.8	19	5 22	7.2	12 06	1.2	Sa	6 19	7.3	. .	. .	19	6 46	7.3	0 41	0.5	19	8 41	7.3	0 49	1.1	Tu	7 11	6.9	1 35	2.0	W	7 43	6.8	2 07	2.2
M	17 02	5.8	22 55	1.4	W	17 43	4.7	23 22	1.1	Su	18 38	5.3	12 53	0.4	Tu	18 50	7.1	12 58	0.4	W	18 55	8.7	12 36	0.9	W	19 33	9.4	13 00	1.7	Th	20 02	9.4	13 27	2.2
20	5 28	8.2	12 04	1.5	20	5 57	7.5	12 41	0.8	Su	6 40	7.4	0 25	0.4	W	7 06	7.2	1 06	0.4	Th	7 03	7.1	1 16	1.1	F	7 41	6.6	2 08	2.2	Th	8 25	6.6	2 44	2.5
Tu	17 40	5.8	23 27	1.2	Th	18 18	4.9	23 55	0.9	M	19 02	5.6	13 15	0.2	Th	19 21	7.3	13 16	0.3	F	19 39	8.8	13 00	0.9	Sa	20 06	9.0	13 29	2.0	F	20 42	8.9	14 06	2.6
21	6 02	8.5	. .	. .	21	6 28	7.7	. .	. .	21	7 10	7.3	0 53	0.3	21	7 29	7.0	1 31	0.4	21	7 27	6.8	1 42	1.3	21	8 17	6.2	2 46	2.6	21	9 13	6.4	3 26	2.7
F	18 16	5.8	12 39	1.2	F	18 48	5.0	13 10	0.6	Tu	19 25	5.9	13 35	0.2	F	19 44	7.5	13 34	0.4	Sa	19 47	8.6	13 23	1.1	Su	20 43	8.5	14 00	2.5	Sa	21 26	8.3	14 50	3.2
22	6 33	8.6	0 00	1.2	22	6 57	7.8	0 27	0.7	W	7 34	7.2	1 21	0.2	22	7 53	6.6	1 58	0.7	22	7 52	6.4	2 12	1.7	22	9 05	5.8	3 32	3.0	22	10 11	6.2	4 14	3.0
Sa	18 48	5.6	13 13	1.2	Sa	19 15	5.1	13 37	0.6	Th	19 48	6.1	13 54	0.2	Su	20 11	7.4	13 54	0.5	M	20 17	8.3	13 46	1.4	Tu	21 30	7.8	14 46	3.3	Su	22 17	7.5	15 46	3.8
23	7 03	8.5	0 28	1.2	23	7 25	7.7	0 57	0.7	23	7 56	6.8	1 47	0.3	23	8 14	6.1	2 25	1.1	23	8 21	5.9	2 47	2.2	23	9 46	5.4	4 22	3.5	23	11 27	6.2	5 13	3.3
F	19 19	5.5	13 46	1.3	Su	19 43	5.2	14 02	0.6	F	20 15	6.1	14 13	0.3	M	20 39	7.1	14 16	0.6	Tu	20 52	7.7	14 12	1.9	W	22 27	7.0	15 25	4.0	M	23 30	6.8	17 10	4.4
24	7 33	8.2	0 57	1.4	M	7 52	7.4	1 27	0.8	Sa	8 18	6.4	2 15	0.6	Tu	8 37	5.6	2 57	1.7	W	8 59	5.3	3 27	2.9	Th	24	7.1	. .	. .	Tu	. .	. .	6 32	3.5
Sa	19 49	5.3	14 18	1.4	Tu	20 11	5.2	14 26	0.7	Su	20 42	5.1	14 39	0.5	W	21 13	6.6	14 29	1.2	Th	21 35	7.0	14 45	2.6	F	22 48	8.3	17 42	4.6	W	13 25	6.4	19 24	4.7
25	8 03	7.9	1 26	1.6	25	8 18	7.0	1 55	0.9	M	8 42	5.8	2 43	1.0	25	9 00	4.9	3 33	2.4	25	9 44	4.7	4 32	3.5	25	0 33	6.5	5 02	3.6	25	1 10	6.4	7 53	3.4
Su	20 21	5.1	14 49	1.7	W	20 40	5.2	14 50	0.9	Tu	21 11	5.9	14 56	0.7	Th	21 57	6.0	15 02	1.6	F	22 51	6.2	15 14	3.4	Sa	14 46	6.1	20 29	4.4	Th	14 49	7.0	21 10	4.3
26	8 32	7.3	1 56	1.9	26	8 45	6.5	2 26	1.3	Tu	9 06	5.3	3 15	1.6	26	9 21	4.2	4 34	3.2	26	. .	. .	7 36	3.8	26	2 22	6.5	9 04	3.1	26	2 41	6.2	8 58	3.2
M	20 57	4.9	15 21	2.0	Th	21 13	5.1	15 14	1.1	W	21 48	5.6	15 19	1.0	F	22 21	5.3	15 32	2.5	Su	. .	. .	. .	. .	M	15 38	7.0	21 44	3.7	Tu	15 47	7.7	22 19	3.7
27	9 02	6.8	2 26	2.3	27	9 12	5.9	3 00	1.7	W	9 28	4.6	3 57	2.3	27	. .	. .	. .	. .	M	1 46	5.9	9 25	3.2	27	3 21	6.8	9 48	3.0	W	3 50	6.4	9 50	2.8
Tu	21 42	4.7	15 56	2.3	F	21 55	5.0	15 41	1.2	Th	22 42	5.1	15 46	1.5	Sa	. .	. .	17 02	3.4	Tu	15 45	5.3	21 15	3.8	Th	16 16	7.8	22 33	3.4	Th	16 32	8.4	23 06	3.1
28	9 36	6.1	3 02	2.8	28	9 40	5.2	3 26	2.2	28	9 56	3.9	5 02	2.0	28	2 45	5.3	10 26	2.7	28	3 23	6.4	10 02	2.6	28	4 21	7.1	10 25	2.2	28	4 42	6.5	10 32	2.6
W	22 43	4.3	16 36	2.5	Sa	22 44	4.8	16 12	1.6	F	. .	. .	16 24	2.0	Su	10 21	4.3	21 33	3.0	W	16 16	6.3	22 11	2.9	F	16 53	8.6	23 14	2.5	F	17 13	9.0	23 50	2.7
29	10 30	5.4	3 53	3.4	29	10 34	4.5	4 32	2.8	29	0 23	4.7	. .	. .	29	4 02	6.1	10 48	2.0	29	4 12	7.0	10 34	2.0	29	5 01	7.3	10 58	1.8	29	5 27	6.7	11 12	2.4
Th	. .	. .	17 32	2.7	Su	. .	. .	16 52	1.9	Sa	. .	. .	16 45	2.6	M	16 48	5.2	22 29	2.1	Th	16 46	7.3	22 52	2.2	Sa	17 27	9.2	23 52	2.1	Sa	17 49	9.4	. .	. .
30	0 27	4.6	5 48	3.9	30	0 07	4.7	5 30	3.3	30	3 21	5.1	10 57	2.4	30	4 43	6.8	11 12	1.3	30	4 50	7.4	11 03	1.5	30	5 27	7.3	11 31	1.8	30	6 04	6.7	0 27	2.2
F	11 36	4.8	18 52	2.7	M	11 06	3.8	18 06	2.2	Su	16 20	3.5	21 30	2.2	Tu	17 14	6.2	23 08	1.4	F	17 16	8.1	23 28	1.6	Su	17 59	9.6	. .	. .	Su	18 22	9.6	11 47	2.2
					31	2 14	4.9	10 00	3.0											21	5 26	7.7	11 32	1.1										
					M	13 55	3.3	20 07	2.2											Tu	17 46	8.5	. .	. .										

KOETAI RIVER ENTRANCE (Muara Bayor), BORNEO, 1944

Time meridian 112° 30' E. The hours of the day are numbered consecutively from 0h (midnight) to 23h (11 00 p. m.). 12h is noon. All hours greater than 12 are in the afternoon (p. m.).

Heights are reckoned from the datum of soundings on the largest charts of the locality which is about 1 foot below mean low water springs.

TABLE III - 8b

JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER					NOVEMBER					DECEMBER				
Day	High		Low*		Day	High		Low*		Day	High		Low*		Day	High		Low*		Day	High		Low*		Day	High		Low*		Day	High		Low*	
	Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.
	h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.
1	6 30	1.1	9 30	1.0	1	5 03	1.6	12 14	1.0	1	5 33	2.7	... ..	..	1	7 02	3.4	15 25	−0.2	1	7 30	2.9	0 15	0.2	1	8 20	1.4	2 47	−0.1	1	4 28	0.4	4 12	−0.2
Th	15 58	1.7	23 36	0.5	Su	15 47	1.1	21 51	0.6	Tu	... ..	..	15 06	0.0	F	20 01	0.3	23 44	0.1	Su	19 50	1.3	14 35	0.2	M	20 30	3.1	13 36	0.2	F	20 48	3.8	12 48	−0.2
2	6 18	1.5	11 56	1.0	2	5 36	2.1	... ..	..	2	6 27	3.1	... ..	..	2	7 47	3.5	... ..	..	2	8 10	2.7	1 22	0.0	2	8 50	1.0	3 42	−0.2	2	5 51	0.2	5 05	−0.2
F	17 09	1.5	23 39	0.5	Su	... ..	..	13 40	0.5	Th	... ..	..	15 32	−0.1	Sa	20 10	0.6	15 39	−0.1	M	20 16	1.8	14 43	0.3	Tu	21 01	3.4	13 47	0.1	Sa	21 27	3.8	13 13	−0.3
3	6 25	1.9	13 05	0.7	3	6 12	2.6	... ..	..	3	7 14	3.5	... ..	..	3	8 31	3.4	0 56	−0.1	3	8 47	2.3	2 21	−0.1	3	9 17	0.6	4 37	−0.1	3	... ..	..	6 00	−0.1
Sa	18 10	1.3	23 50	0.5	M	... ..	..	14 33	0.3	F	... ..	..	16 25	−0.3	Su	20 32	0.9	15 54	0.1	Tu	20 48	2.3	14 52	0.3	W	21 39	3.6	14 00	−0.1	Su	22 07	3.6	... ..	..
4	6 46	2.3	... ..	..	4	6 46	3.0	... ..	..	4	7 57	3.7	... ..	..	4	9 05	3.2	1 55	−0.2	4	9 21	1.9	3 17	−0.2	4	9 34	0.4	5 36	0.0	4	... ..	..	7 00	−0.2
Su	18 51	1.0	13 56	0.4	Tu	... ..	..	15 15	0.0	Sa	... ..	..	16 55	−0.3	M	21 02	1.4	16 02	0.2	W	21 21	2.8	14 56	0.3	Th	22 16	3.5	14 13	−0.2	M	22 45	3.4	... ..	..
5	7 10	2.7	0 00	0.4	5	7 25	3.4	... ..	..	5	8 40	3.8	... ..	..	5	9 42	2.6	2 49	−0.3	5	9 45	1.4	4 12	−0.1	5	... ..	..	6 48	0.1	5	... ..	..	8 00	−0.1
M	19 31	0.8	14 43	0.1	W	... ..	..	15 56	−0.2	Su	20 46	0.3	16 48	−0.2	Tu	21 37	1.8	16 11	0.3	Th	21 57	3.0	15 03	0.2	Sa	22 58	3.4	... ..	..	Tu	23 25	3.0	... ..	..
6	7 40	3.2	0 30	0.3	6	8 06	3.7	... ..	..	6	9 21	3.7	1 24	−0.3	6	10 13	2.2	3 44	−0.1	6	10 06	0.9	5 09	0.0	6	... ..	..	8 00	−0.2	6	... ..	..	8 30	0.1
Tu	20 10	0.5	15 30	−0.1	Th	... ..	..	16 38	−0.3	Su	21 17	0.6	17 09	0.0	W	22 17	2.2	16 17	0.3	F	22 35	3.2	15 10	0.0	M	23 44	3.1	... ..	..	W	... ..	..	... ..	..
7	8 14	3.5	0 24	0.1	7	8 46	3.9	... ..	..	7	10 00	3.4	2 19	−0.3	7	10 40	1.7	4 42	0.1	7	10 58	0.6	6 18	0.2	7	... ..	..	9 00	−0.1	7	0 08	2.7	9 30	0.3
W	20 37	0.3	16 18	−0.2	F	... ..	..	17 21	−0.3	M	21 53	0.9	17 26	0.2	Th	23 00	2.5	16 23	0.3	Sa	23 19	3.1	15 17	−0.1	Tu	... ..	..	... ..	..	Th	... ..	..	... ..	..
8	8 40	3.7	0 44	−0.1	8	9 29	3.9	... ..	..	8	10 26	3.0	3 14	−0.2	8	10 58	1.2	5 48	0.3	8	10 00	0.5	7 30	0.4	8	0 37	2.7	10 00	0.1	8	0 54	2.3	10 00	0.4
Th	... ..	..	17 10	−0.2	Sa	21 28	0.1	17 58	−0.2	Tu	22 35	1.3	17 37	−0.3	F	23 48	2.7	16 32	0.2	Su	... ..	..	15 24	−0.2	M	... ..	..	... ..	..	F	... ..	..	... ..	..
9	9 31	3.9	... ..	..	9	10 11	3.8	1 50	−0.4	9	11 07	2.5	4 13	0.0	9	10 58	0.8	7 24	0.6	9	0 08	3.0	10 30	−0.1	9	1 50	2.4	11 00	0.2	9	1 51	1.9	10 42	0.5
F	... ..	..	18 06	−0.2	Su	22 05	0.2	18 34	0.0	W	23 29	1.6	17 47	0.4	Sa	... ..	..	16 37	0.0	M	... ..	..	... ..	..	Tu	... ..	..	... ..	..	Sa	17 00	1.1	20 00	1.0
10	10 14	3.8	... ..	..	10	10 50	3.5	2 39	−0.3	10	11 36	1.9	5 20	0.4	10	0 48	2.7	... ..	..	10	1 14	2.7	11 00	0.0	10	3 21	2.1	12 30	0.2	10	3 09	1.6	10 53	0.5
Sa	... ..	..	19 14	−0.2	M	22 48	0.5	19 00	0.2	Th	... ..	..	17 57	0.4	Su	... ..	..	12 00	0.0	Tu	... ..	..	... ..	..	W	15 50	1.9	22 00	0.5	Su	18 02	1.5	23 55	1.1
11	10 58	3.6	... ..	..	11	11 31	3.1	3 31	−0.1	11	0 27	1.9	6 46	0.7	11	2 00	2.6	... ..	..	11	2 48	2.5	... ..	..	11	4 44	1.9	12 21	0.4	11	4 20	1.3	11 03	0.5
Su	... ..	..	20 25	−0.3	Tu	23 56	0.8	19 24	0.3	F	11 57	1.3	18 07	0.3	M	... ..	..	12 30	0.0	W	... ..	..	12 00	0.1	Th	18 54	1.3	23 51	1.0	M	18 12	1.0	... ..	..
12	11 47	3.3	... ..	..	12	... ..	..	4 26	0.3	12	1 36	2.2	9 25	0.8	12	3 40	2.6	... ..	..	12	4 32	2.3	13 44	0.2	12	5 45	1.8	... ..	..	12	5 37	1.1	1 12	0.6
M	... ..	..	21 25	0.0	W	12 12	2.5	19 41	0.4	Sa	12 05	0.9	18 15	0.2	Tu	... ..	..	13 00	0.0	Th	19 00	0.8	22 00	0.7	F	18 54	1.7	12 13	0.4	Tu	18 34	1.3	11 14	0.5
13	... ..	..	... ..	..	13	1 22	1.1	6 04	0.7	13	3 01	2.4	... ..	..	13	5 14	2.6	... ..	..	13	5 45	2.2	13 44	0.3	13	6 33	1.6	0 58	0.7	13	6 32	0.9	2 03	0.5
Tu	12 40	2.9	21 47	0.2	Th	12 50	1.9	20 00	0.4	Su	... ..	..	19 01	0.1	W	... ..	..	14 00	0.1	F	19 27	1.0	23 45	0.8	Sa	19 10	2.0	12 44	0.4	W	19 00	2.7	11 27	0.4
14	... ..	..	... ..	..	14	2 46	1.6	8 43	1.0	14	4 27	2.7	... ..	..	14	6 22	2.7	14 48	0.1	14	6 36	2.2	... ..	..	14	7 09	1.4	1 42	0.5	14	7 17	0.7	2 47	0.2
W	13 41	2.4	22 04	0.3	F	13 32	1.3	20 18	0.4	M	... ..	..	19 48	0.1	Th	20 00	0.6	23 10	0.5	Sa	19 27	1.3	13 50	0.3	Su	19 30	2.4	12 48	0.4	Th	19 20	3.1	11 44	0.3
15	4 30	1.0	7 35	0.9	15	4 08	2.1	12 00	0.6	15	5 37	2.9	... ..	..	15	7 08	2.7	... ..	..	15	7 13	2.2	0 48	0.5	15	7 42	1.2	2 51	0.3	15	7 57	0.5	3 20	0.0
Th	14 30	1.9	22 23	0.4	Sa	14 30	0.3	20 30	0.3	Tu	... ..	..	15 34	0.0	F	19 53	0.8	14 56	0.2	Su	19 47	1.6	13 56	0.3	M	19 53	2.8	12 57	0.3	F	20 02	3.4	12 06	0.1
16	5 15	1.6	11 12	1.0	16	5 10	2.6	... ..	..	16	6 35	3.1	... ..	..	16	7 44	2.7	0 32	0.4	16	7 44	2.0	1 32	0.4	16	8 14	1.0	3 06	0.1	16	8 21	0.3	4 17	−0.1
F	16 04	1.4	22 52	0.3	Su	... ..	..	21 35	0.2	W	... ..	..	15 37	0.0	Sa	20 06	1.1	15 00	0.2	M	19 58	1.9	14 03	0.4	Tu	20 17	3.1	13 06	0.3	Sa	20 27	3.6	12 31	0.0
17	5 50	2.2	13 04	0.6	17	6 04	3.0	... ..	..	17	7 22	3.1	... ..	..	17	8 16	2.6	1 23	0.2	17	8 16	1.9	2 13	0.2	17	8 44	0.8	3 58	0.0	17	... ..	..	... ..	..
Sa	17 25	1.8	23 49	0.2	M	... ..	..	15 25	0.1	Th	20 05	0.4	15 46	0.0	Su	20 26	1.4	15 30	0.3	Tu	20 22	2.2	14 09	0.4	W	20 47	3.3	13 18	0.2	Su	21 13	3.8	... ..	..
18	6 25	2.8	14 17	0.3	18	6 49	3.3	... ..	..	18	8 03	3.2	0 04	0.2	18	8 45	2.5	2 04	0.2	18	8 43	1.7	2 51	0.1	18	9 10	0.5	4 36	−0.1	18	... ..	..	5 31	−0.2
Su	18 23	0.6	23 13	0.1	Tu	... ..	..	15 42	0.0	F	20 25	0.6	16 00	0.1	M	20 48	1.6	15 21	0.3	W	20 43	2.5	14 15	0.4	Th	21 21	3.5	13 24	0.0	M	21 56	3.8	... ..	..
19	7 04	3.2	15 11	0.0	19	7 32	3.4	... ..	..	19	8 38	3.1	1 00	0.1	19	9 14	2.3	2 42	0.1	19	9 10	1.4	3 31	0.0	19	9 35	0.2	5 30	−0.1	19	... ..	..	6 48	−0.3
M	19 16	0.4	23 36	0.0	W	... ..	..	16 15	−0.1	Sa	20 44	0.8	16 12	0.2	Tu	21 10	1.9	15 28	0.4	Th	21 07	2.8	14 25	0.3	F	21 59	3.6	13 46	−0.1	Tu	22 38	3.7	... ..	..
20	7 41	3.5	... ..	..	20	8 12	3.5	... ..	..	20	9 10	3.0	1 50	0.1	20	9 37	2.1	3 20	0.1	20	9 36	1.1	4 14	0.0	20	... ..	..	6 40	0.0	20	... ..	..	7 46	−0.2
Tu	... ..	..	16 01	−0.1	Th	... ..	..	16 36	−0.1	Su	21 11	1.0	16 26	0.2	W	21 34	2.1	15 37	0.4	F	21 36	2.0	14 32	0.3	Sa	22 42	3.5	... ..	..	W	23 26	3.4	... ..	..
21	8 19	3.7	... ..	..	21	8 48	3.5	... ..	..	21	9 39	2.8	2 38	0.0	21	10 06	1.8	4 00	0.1	21	9 58	0.8	5 02	0.0	21	... ..	..	8 30	−0.2	21	... ..	..	8 38	0.0
W	... ..	..	16 42	−0.1	F	21 00	0.4	17 01	0.0	M	21 33	1.2	16 39	0.3	Th	22 00	2.3	15 41	0.4	Sa	22 10	1.1	14 38	0.2	Su	23 30	3.4	... ..	..	Th	... ..	..	... ..	..
22	8 56	3.7	... ..	..	22	9 24	3.0	1 27	−0.1	22	10 06	2.6	3 06	0.1	22	10 27	1.5	4 43	0.2	22	10 14	0.5	6 04	0.1	22	... ..	..	9 30	−0.2	22	... ..	..	9 02	0.2
Th	... ..	..	17 22	−0.2	Sa	21 25	0.5	17 22	0.1	Tu	22 10	1.4	16 50	0.4	F	22 31	2.5	15 44	0.4	Su	22 49	3.2	14 43	0.0	M	... ..	..	... ..	..	F	... ..	..	... ..	..
23	9 33	3.6	... ..	..	23	9 56	3.2	2 09	0.0	23	10 30	2.3	3 45	0.2	23	10 45	1.1	5 26	0.3	23	... ..	..	7 30	−0.1	23	0 29	3.1	10 00	0.0	23	0 13	2.9	9 02	0.2
F	... ..	..	18 00	−0.2	Su	21 56	0.6	17 46	0.2	W	22 30	1.5	16 59	0.5	Sa	23 10	2.6	15 49	0.3	M	23 27	3.1	... ..	..	Tu	... ..	..	... ..	..	Sa	... ..	..	... ..	..
24	10 09	3.4	18 40	0.0	M	22 28	0.8	18 06	0.3	Th	23 05	1.8	17 07	0.5	Su	23 57	2.7	15 55	0.2	Tu	... ..	..	9 00	−0.1	W	1 40	2.8	10 45	−0.1	Su	1 55	2.5	9 22	0.4
Sa	... ..	..	... ..	..	Tu	23 03	0.9	18 25	0.4	F	23 45	2.0	17 11	0.5	M	... ..	..	16 05	0.2	W	23 57	2.7	15 55	0.2	Th	... ..	..	... ..	..	M	16 30	1.5	22 13	1.0
25	10 42	3.2	... ..	..	25	10 56	2.7	3 25	0.2	25	11 18	1.6	5 17	0.4	25	... ..	..	10 00	0.1	25	0 42	3.0	10 00	−0.2	25	2 00	2.4	11 32	0.2	25	3 10	1.4	9 35	0.4
Su	... ..	..	19 22	0.1	W	23 03	0.9	18 25	0.4	Sa	23 45	2.0	17 11	0.5	Tu	... ..	..	16 05	0.2	Th	... ..	..	... ..	..	F	18 00	1.0	21 25	0.9	Tu	17 22	1.3	... ..	..
26	11 17	2.9	20 05	0.3	26	11 26	2.4	4 06	0.4	26	11 41	1.2	6 28	0.7	26	1 04	2.7	11 00	0.0	26	2 10	2.8	11 00	−0.1	26	4 20	2.0	11 40	0.2	26	4 25	1.0	0 42	0.7
M	... ..	..	... ..	..	Th	23 46	1.1	18 37	0.5	Su	... ..	..	17 12	0.5	W	... ..	..	... ..	..	F	... ..	..	... ..	..	Sa	18 05	1.6	23 50	0.7	W	18 02	1.7	10 14	0.3
27	11 54	2.6	... ..	..	27	11 50	2.0	4 57	0.6	27	0 38	2.1	9 00	0.7	27	2 43	2.7	... ..	..	27	3 46	2.7	... ..	..	27	5 32	1.7	11 48	0.3	27	5 47	0.6	2 10	0.4
Tu	... ..	..	20 36	0.4	Th	... ..	..	19 49	0.6	Su	11 00	0.8	17 02	0.4	Th	... ..	..	12 25	−0.2	Sa	... ..	..	... ..	..	Su	18 20	2.2	... ..	..	Th	18 42	3.1	10 36	0.1
28	... ..	..	... ..	..	28	0 46	1.3	6 11	0.8	28	1 53	2.3	... ..	..	28	4 28	2.8	... ..	..	28	5 07	2.6	13 09	0.1	28	6 26	1.3	1 16	0.4	28	... ..	..	3 06	0.0
W	12 33	2.2	21 03	0.5	F	12 19	1.6	18 59	0.6	M	... ..	..	12 15	0.2	Th	... ..	..	13 30	−0.2	Su	18 57	1.0	23 17	0.6	M	19 04	2.8	12 00	0.2	Th	19 22	3.5	... ..	..
29	... ..	..	... ..	..	29	1 55	1.6	8 28	1.0	29	3 31	2.5	... ..	..	29	5 43	3.0	14 18	−0.1	29	5 43	2.6	... ..	..	Tu	19 05	1.5	13 13	0.2	F	19 37	3.3	12 16	0.1
Th	13 17	1.8	21 24	0.6	Sa	12 37	1.2	19 09	0.6	Tu	... ..	..	13 20	0.0	F	12 45	0.5	22 40	0.4	M	19 05	1.5	13 13	0.2	W	19 37	3.3	12 16	0.1	Sa	20 05	3.7	... ..	..
30	4 36	1.2	9 50	1.1	30	3 16	1.9	... ..	..	30	5 00	2.8	... ..	..	30	6 40	3.0	... ..	..	30	7 01	2.1	0 43	0.4	30	7 56	0.6	2 19	−0.1	30	... ..	..	4 36	−0.2
Su	14 09	1.4	21 38	0.6	Su	... ..	..	14 00	0.5	W	... ..	..	14 56	−0.2	Sa	19 25	0.8	14 26	0.0	M	19 24	2.1	13 20	0.3	Th	20 15	3.6	12 20	0.0	Su	20 43	3.7	... ..	..
					31	4 34	2.3	... ..	..	31	6 07	3.1	... ..	..						31	7 41	1.8	1 49	0.1								5 12	−0.1
					M	... ..	..	15 23	0.3	Th	... ..	..	15 10	−0.2						Tu	19 54	2.7	13 20	0.3								... ..	..

JOLO, PHILIPPINE ISLANDS, 1944

Time meridian 120° E. The hours of the day are numbered consecutively from 0h (midnight) to 23h (11 00 p. m.). 12h is noon. All hours greater than 12 are in the afternoon (p. m.).

Heights are reckoned from the datum of soundings on charts of the locality which is mean lower low water.

*on days when tide is diurnal, low water has a stand of about 7 hours. Predictions are for beginning of stand.

TABLE III - 8c

Month Day	Week Day	JUNE. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.	Month Day	Week Day	JULY. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.	Month Day	Week Day	AUGUST. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.	Month Day	Week Day	SEPTEMBER. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.	Month Day	Week Day	OCTOBER. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.	Month Day	Week Day	NOVEMBER. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.	Month Day	Week Day	DECEMBER. HIGH WATER Time h. m.	Ht. ft.	LOW WATER Time h. m.	Ht. ft.
1	Th.	0816	4·3	0043	1·9	1	S.	0725	4·9	0017	2·3	1	Tu.	0751	6·0	0118	3·3	1	F.	0915	6·8	0308	3·1	1	S.	1000	6·8	0349	2·4	1	W.	1144	5·7	0505	0·9	1	F.	1258	4·7	0540	0·1
		1845	4·2	1349	3·2			1934	3·6	1404	2·6			2325	3·5	1526	1·4			2356	4·9	1625	0·7			2311	5·0	1630	1·2			2308	7·1	1655	3·5			2325	8·1	1654	3·6
2	F.	0836	4·8	0140	1·9	2	S.	0800	5·1	0120	2·4	2	W.	0840	6·5	0224	3·2	2	S.	1007	7·0	0353	2·6	2	M.	1051	6·6	0430	1·6	2	Th.	1235	5·3	0544	0·6	2	S.	1354	4·5	0619	0·1
		2010	4·1	1439	2·5			2115	3·6	1456	2·9			—	—	1606	0·9			—	—	1658	0·6			2326	5·4	1700	1·3			2338	7·5	1724	2·8			2350	8·1	1724	3·6
3	S.	0859	5·2	0224	1·9	3	M.	0834	5·5	0211	2·6	3	Th.	0905	5·3	0311	3·1	3	Tu.	1141	6·4	0436	2·1	3	F.	1141	6·2	0511	1·2	3	S.	—	—	0626	0·5	3	S.	—	—	0658	0·9
		2120	4·1	1520	1·9			2243	3·5	1539	1·4			0926	6·9	1644	0·5			1056	7·1	1731	0·6			2347	5·9	1731	1·6			1326	4·8	1751	3·1			1446	4·3	1751	3·8
4	S.	0921	5·1	0303	1·9	4	Tu.	0907	6·1	0254	2·6	4	F.	0938	5·3	0356	2·9	4	M.	1221	4·9	0527	1·7	4	W.	—	—	0554	0·8	4	S.	0010	7·5	0709	0·8	4	M.	0027	7·9	0749	1·2
		2221	3·9	1555	1·4			2350	3·5	1617	0·9			1012	7·3	1720	0·3			1245	7·0	1805	0·9			2229	6·0	1800	2·4			1422	4·4	1814	3·4			1545	4·1	1811	3·4
5	M.	0946	6·0	0333	2·1	5	W.	0944	6·9	0330	2·9	5	S.	0106	3·6	0437	2·6	5	Tu.	0040	4·7	0600	1·4	5	Th.	0014	6·7	0635	0·6	5	S.	0044	7·5	0751	1·0	5	Tu.	0103	7·5	0819	1·4
		2322	3·7	1630	0·9			—	—	1055	0·4			1100	7·4	1756	0·2			1233	6·5	1836	1·3			2326	5·3	1830	2·4			1526	3·9	1824	3·6			1704	4·2	1812	4·1
6	Tu.	1014	6·4	0401	2·4	6	Th.	0050	3·5	0404	2·4	6	S.	0128	3·7	0519	2·4	6	W.	0100	3·6	0643	1·3	6	F.	0044	6·5	0719	0·8	6	M.	0121	7·4	0844	1·7	6	W.	0138	6·9	0900	1·8
		—	—	1706	0·5			1023	7·1	1734	0·3			1149	7·4	1833	0·4			1319	6·0	1908	1·7			1404	4·6	1854	2·8			—	—	—	—			—	—	—	—
7	W.	0026	3·6	0430	2·5	7	F.	0130	3·4	0440	2·9	7	M.	0144	3·5	0604	2·1	7	Th.	0127	5·4	0729	1·3	7	S.	0115	6·7	0805	1·1	7	Tu.	0154	7·1	0936	2·2	7	Th.	0215	6·4	0948	2·2
		1044	6·6	1745	0·2			1105	7·3	1813	0·2			1236	7·1	1909	0·6			1405	5·4	1937	2·1			1454	4·4	1910	3·2			—	—	—	—			—	—	—	—
8	Th.	0128	3·3	0459	2·6	8	S.	0219	3·4	0518	2·9	8	Tu.	0220	3·4	0649	2·0	8	F.	0158	5·1	0819	1·5	8	S.	0150	6·5	0859	1·5	8	W.	0236	6·5	1054	2·3	8	F.	0300	5·7	1052	2·6
		1116	6·3	1823	0·4			1150	7·1	1852	0·1			1323	6·6	1945	1·0			1450	4·5	2003	2·7			1630	3·5	1835	3·4			—	—	—	—			2001	4·6	2326	4·6
9	F.	0216	3·2	0526	2·8	9	S.	0250	3·4	0558	2·8	9	W.	0323	4·4	0736	2·0	9	S.	0235	5·0	0917	1·8	9	M.	0229	6·4	1010	2·0	9	Th.	0342	5·8	—	—	9	S.	0412	5·1	—	—
		1155	7·1	1904	0·0			1238	7·3	1934	0·4			1410	6·0	2020	1·6			1550	3·8	2020	3·0			—	—	—	—			2206	5·0	1301	2·6			2006	5·1	1214	2·8
10	S.	0324	3·1	0555	2·9	10	M.	0312	3·4	0643	2·7	10	Th.	0351	4·7	0832	2·1	10	S.	0318	5·8	1041	2·1	10	Tu.	0316	6·0	1316	2·2	10	F.	0540	3·4	0110	4·8	10	S.	0620	4·6	0142	4·1
		1239	7·0	1948	0·3			1325	6·9	2015	0·6			1459	5·5	2055	2·1			—	—	—	—			—	—	—	—			2136	3·3	2351	2·6			2024	5·6	1315	2·9
11	S.	0425	3·1	0625	2·9	11	Tu.	0334	3·6	0734	2·6	11	F.	0330	5·0	0939	2·5	11	M.	0419	5·7	—	—	11	W.	0443	5·5	—	—	11	S.	0732	5·3	0223	4·2	11	M.	0809	4·5	0239	3·5
		1326	6·8	2035	0·5			1414	6·9	2058	1·1			1556	4·3	2130	2·6			—	—	1332	2·9			2250	4·5	2432	2·9			2131	5·6	2426	2·5			2046	6·1	2403	2·9
12	M.	0539	3·2	0701	3·1	12	W.	0404	3·5	0838	2·6	12	S.	0419	5·2	1120	2·4	12	Tu.	0536	5·6	—	—	12	Th.	0646	5·4	0121	4·4	12	S.	0841	5·3	0302	3·5	12	Tu.	0920	4·5	0319	3·8
		1415	6·4	2126	0·9			1507	5·6	2142	1·6			1738	3·4	2202	3·1			2306	4·0	1500	1·7			2326	4·8	2501	1·9			2141	6·0	2459	2·5			2109	6·5	2442	3·0
13	Tu.	0630	3·4	0810	3·2	13	Th.	0446	4·3	1000	2·6	13	S.	0525	5·4	1334	2·0	13	W.	0723	5·7	0212	3·9	13	F.	0810	5·0	0235	3·8	13	M.	0935	5·4	0336	2·9	13	W.	1025	4·5	0354	2·1
		1514	5·9	2226	1·4			1620	5·2	2232	2·1			2204	3·6	2301	3·3			2310	4·3	1535	1·5			2234	5·0	2521	1·8			2159	6·4	2526	2·5			2136	7·0	2526	3·4
14	W.	0701	3·5	1003	3·3	14	F.	0538	4·9	1154	2·6	14	M.	0640	5·7	—	—	14	Th.	0831	6·0	0231	3·5	14	S.	0909	5·0	0316	3·1	14	Tu.	1025	5·4	0409	2·3	14	Th.	1126	4·5	0426	1·6
		1625	5·5	2334	1·4			1739	4·9	2330	2·5			2306	3·7	1458	1·6			2321	4·6	1559	1·5			2339	5·2	2545	1·7			2215	6·8	2555	2·6			2201	7·6	2547	3·2
15	Th.	0726	4·1	—	—	15	S.	0635	5·3	—	—	15	Tu.	0749	6·0	0112	3·5	15	F.	0934	6·4	0331	3·0	15	S.	0955	5·7	0356	2·5	15	W.	1110	5·2	0440	1·9	15	F.	1224	4·4	0459	1·2
		1800	4·5	1224	3·0			1958	3·6	1342	2·1			2332	3·8	1546	1·2			2330	4·5	1621	1·9			2339	5·5	1609	1·8			2336	7·0	2621	2·9			2232	7·6	2616	3·4
16	F.	0750	4·3	0040	2·0	16	S.	0729	5·6	0039	2·9	16	W.	0845	6·4	0227	3·4	16	S.	1009	6·2	0356	2·7	16	M.	1036	5·3	0421	2·3	16	Th.	1156	5·1	0510	1·5	16	S.	2320	4·4	0534	0·6
		1945	4·3	1356	2·4			2157	3·5	1454	1·5			2359	3·9	1619	0·9			2340	4·8	1644	1·3			2301	5·9	1634	2·0			2257	7·4	2646	2·0			2301	7·5	2642	2·6
17	S.	0820	5·4	0135	2·2	17	M.	0816	6·2	0242	3·1	17	Th.	0934	6·5	0325	3·1	17	F.	1050	6·0	0431	2·3	17	Tu.	1116	5·7	0451	1·9	17	F.	1245	4·9	0541	1·3	17	S.	1414	3·8	0609	0·5
		2115	4·2	1458	1·6			2317	3·6	1545	1·0			—	—	1647	0·9			2350	4·9	1706	1·4			2316	6·0	1659	2·0			2320	7·5	2710	3·0			2337	7·6	1711	3·3
18	S.	0851	6·0	0221	2·4	18	Tu.	0900	6·6	0334	3·4	18	F.	0020	4·9	0359	2·8	18	M.	1126	6·6	0505	2·0	18	W.	1151	5·9	0524	1·5	18	S.	1334	4·5	0616	1·1	18	M.	—	—	0647	0·4
		2233	3·9	1546	0·9			—	—	1626	0·4			1018	6·6	1714	0·9			—	—	1734	1·5			2335	6·3	1724	2·3			2350	7·7	2731	3·5			2501	3·6	1739	3·4
19	M.	0925	6·5	0300	2·5	19	W.	0008	3·6	0320	2·9	19	S.	0036	4·9	0437	2·5	19	Tu.	0005	5·9	0536	1·8	19	Th.	1229	5·3	0554	1·3	19	S.	—	—	0652	1·0	19	Tu.	0026	7·6	0726	0·5
		2341	3·6	1630	0·5			0044	6·9	2701	0·5			1059	6·5	2740	0·9			1200	5·9	1759	1·6			2355	6·5	2746	2·5			1425	4·1	2749	3·8			1547	3·5	2807	3·6
20	Tu.	1000	6·0	0339	2·6	20	Th.	0048	3·6	0359	2·9	20	S.	0050	4·1	0512	2·4	20	W.	0020	5·9	0001	1·5	20	F.	1301	4·8	0626	1·2	20	M.	0021	7·8	0734	1·0	20	W.	0058	7·5	0808	0·8
		—	—	1710	0·3			1025	6·9	2735	0·5			1136	6·3	2807	1·0			1231	5·5	1834	1·9			—	—	1806	2·4			1610	3·9	2745	3·8			1650	3·6	1843	3·5
21	W.	0041	3·6	0414	2·6	21	F.	0120	3·6	0439	2·8	21	M.	0104	4·2	0547	2·2	21	Th.	0039	5·5	0636	1·5	21	S.	0016	6·8	0700	1·1	21	Tu.	0059	7·7	0819	1·4	21	Th.	0142	7·4	0854	1·1
		1039	7·1	1747	0·1			1206	6·9	2806	0·5			1222	6·2	2834	1·2			1301	5·2	1845	2·2			1331	4·4	1824	3·1			—	—	—	—			2739	3·6	1932	3·3
22	Th.	0134	3·5	0448	2·7	22	S.	0146	3·6	0515	2·7	22	Tu.	0120	4·4	0620	2·0	22	F.	0059	5·1	0711	1·5	22	S.	0045	6·0	0740	1·3	22	W.	0142	7·5	0910	1·8	22	F.	0234	6·8	0942	1·6
		1116	7·0	1824	0·3			1145	6·6	1836	0·6			1245	6·0	1900	1·4			1329	4·8	1905	2·5			1401	3·9	1826	3·4			—	—	—	—			2815	4·9	1000	2·1
23	F.	0217	3·4	0520	2·9	23	M.	0205	3·6	0551	2·6	23	W.	0136	4·6	0652	2·0	23	S.	0124	5·0	0751	1·5	23	M.	0115	6·0	0826	1·5	23	Th.	0235	7·0	1016	2·1	23	S.	0335	5·7	1040	2·1
		1155	6·6	1859	0·5			1222	6·5	1907	1·0			1314	5·6	1927	1·6			1354	4·5	1921	2·8			1449	3·4	1632	3·3			—	—	—	—			2848	4·2	1315	3·6
24	S.	0253	3·4	0553	3·1	24	M.	0230	3·7	0627	2·6	24	Th.	0155	4·8	0729	2·0	24	S.	0154	5·3	0836	1·8	24	Tu.	0154	6·0	0925	1·8	24	F.	0350	6·4	1146	2·5	24	S.	0502	5·0	1153	2·5
		1232	6·6	1934	0·6			1256	6·2	1938	1·2			1342	5·1	1951	2·0			1421	3·7	1916	3·0			—	—	—	—			2205	4·6	2350	4·0			2915	5·0	—	—
25	S.	0321	3·4	0626	3·1	25	Tu.	0240	3·9	0704	2·5	25	F.	0220	5·1	0809	2·1	25	M.	0231	5·9	0939	2·0	25	W.	0250	6·3	1049	2·1	25	S.	0531	5·9	—	—	25	M.	0705	4·9	1216	3·1
		1309	6·4	2008	0·9			1330	5·9	2008	1·4			1408	4·6	2017	2·3			1505	3·1	1714	3·9			—	—	—	—			2051	5·3	1306	2·6			1950	5·0	1812	2·9
26	M.	0350	3·4	0700	3·1	26	W.	0301	4·2	0745	2·6	26	S.	0259	5·2	0859	2·4	26	Tu.	0329	5·8	1115	2·2	26	Th.	0414	6·1	—	—	26	S.	0724	5·6	0151	3·9	26	Tu.	0858	4·6	0243	2·9
		1345	5·9	2045	1·2			1400	5·4	2039	1·6			1439	4·1	2036	2·7			—	—	—	—			—	—	1311	2·1			2059	5·3	1400	2·7			2030	6·1	1350	2·8
27	Tu.	0427	3·6	0745	3·1	27	Th.	0330	4·6	0833	2·9	27	S.	0336	5·3	1006	2·5	27	W.	0456	5·7	—	—	27	F.	0606	5·9	—	—	27	M.	0849	5·6	0249	2·9	27	W.	1030	4·4	0336	2·8
		1421	5·4	2125	1·5			1435	4·9	2111	1·9			1523	3·5	2039	3·0			—	—	1356	1·9			2205	4·8	1433	1·9			2115	6·5	1439	2·8			2106	6·9	1438	2·9
28	W.	0510	3·9	0849	3·1	28	F.	0408	4·7	0933	2·9	28	M.	0435	5·4	—	—	28	Th.	0540	5·9	—	—	28	S.	0745	6·0	0026	1·8	28	Tu.	0957	5·5	0336	2·6	28	Th.	1136	4·2	0419	2·6
		1504	4·9	2210	1·8			1514	4·3	2146	2·3			—	—	1210	2·3			2255	4·3	2451	1·5			2201	5·1	1450	1·8			2139	7·0	1515	2·9			2144	7·3	1500	3·1
29	Th.	0558	4·1	2024	3·4	29	S.	0459	4·8	1100	2·8	29	Tu.	0553	5·6	—	—	29	F.	0801	6·0	0214	3·7	29	S.	0855	6·0	0301	2·1	29	W.	1100	5·3	0419	1·9	29	F.	1232	3·9	0458	3·4
		1559	4·4	2306	2·9			1611	3·6	1228	2·6			—	—	1422	2·9			2254	4·4	2527	1·9			2205	5·3	1521	1·8			2209	7·0	1549	3·1			2222	3·7	2539	3·4
30	F.	0645	4·6	—	—	30	S.	0559	5·0	1319	2·6	30	W.	0714	6·0	—	—	30	S.	0905	6·0	0309	3·4	30	M.	0955	6·0	0414	2·2	30	Th.	1159	5·3	0459	1·9	30	S.	1302	3·9	0538	3·9
		1722	3·9	1242	3·3			2000	3·4	2331	3·2			2330	3·9	1514	1·4			2301	4·4	2556	1·6			2220	6·2	2554	2·0			2303	7·0	1625	3·3			2323	7·0	1625	3·9
31	M.	0657	5·6	—	—	31	Th.	0819	6·5	0021	3·3													31	Tu.	1050	6·0	0425	1·5							31	S.	1402	3·8	0603	4·0
		2220	3·4	1436	2·9			2341	4·0	1552	1·0															2241	6·7	2625	2·3									2342	7·5	1710	3·1

BRITISH NORTH BORNEO-SANDKAN, 1944. Lat. 5° 50′ N. Long. 118° 07′ E

Time meridian 120° E. (Zone −8); 00^h is midnight 12^h is noon. Heights are referred to the datum of the largest scale Admiralty chart of the place and should be *added* to depths, unless preceded by an asterisk (*), when they should be *subtracted*. To find height at times between high and low water *see* Table I.

TABLE III - 8d

Month	Week Day	JUNE. HIGH WATER Time	Ht.	JUNE. LOW WATER Time	Ht.	Month	Week Day	JULY. HIGH WATER Time	Ht.	JULY. LOW WATER Time	Ht.	Month	Week Day	AUGUST. HIGH WATER Time	Ht.	AUGUST. LOW WATER Time	Ht.	Month	Week Day	SEPTEMBER. HIGH WATER Time	Ht.	SEPTEMBER. LOW WATER Time	Ht.	Month	Week Day	OCTOBER. HIGH WATER Time	Ht.	OCTOBER. LOW WATER Time	Ht.	Month	Week Day	NOVEMBER. HIGH WATER Time	Ht.	NOVEMBER. LOW WATER Time	Ht.	Month	Week Day	DECEMBER. HIGH WATER Time	Ht.	DECEMBER. LOW WATER Time	Ht.
		h. m.	ft.	h. m.	ft.			h. m.	ft.	h. m.	ft.			h. m.	ft.	h. m.	ft.			h. m.	ft.	h. m.	ft.			h. m.	ft.	h. m.	ft.			h. m.	ft.	h. m.	ft.			h. m.	ft.	h. m.	ft.
1	Th.	0927	6·1	0215	3·9	1	S.	0858	6·4	0138	3·4	1	Tu.	1001	6·9	0319	3·1	1	F.	1125	7·9	0527	2·4	1	M.	1149	8·1	0600	1·8	1	W.	0038	8·6	0700	0·9	1	F.	0052	8·5	0736	0·9
2	F.	1001	6·6	0319	3·1	2	S.	0947	6·6	0257	3·1	2	W.	1054	7·4	0439	2·8	2	S.	0005	7·2	0616	1·8	2	M.	0026	8·2	0644	1·2	2	Th.	0114	8·7	0750	0·7	2	S.	0128	8·4	0816	0·9
3	S.	1032	7·1	0408	2·7	3	M.	1029	7·2	0402	2·8	3	Th.	1140	8·0	0539	2·4	3	S.	0050	7·8	0702	1·4	3	Tu.	0105	8·5	0736	0·9	3	F.	0147	8·6	0826	0·6	3	S.	0202	8·1	0853	1·2
4	S.	1104	7·5	0452	2·4	4	Tu.	1114	7·7	0501	2·5	4	F.	0020	7·6	0630	2·0	4	M.	0130	8·2	0745	1·1	4	W.	0144	8·6	0806	0·7	4	S.	0220	8·1	0905	1·1	4	M.	0230	7·7	0926	1·6
5	M.	1140	7·7	0534	2·2	5	W.	1158	8·1	0554	2·1	5	S.	0106	7·4	0716	1·6	5	Tu.	0206	8·3	0825	1·0	5	Th.	0218	8·6	0846	0·9	5	M.	0249	7·6	0940	1·7	5	Tu.	0257	7·2	1000	2·1
6	Tu.	—	—	0615	1·8	6	Th.	0030	6·8	0643	1·9	6	S.	0150	7·7	0759	1·5	6	W.	0244	8·2	0901	1·2	6	F.	0246	8·1	0919	1·3	6	M.	0315	7·1	1016	2·4	6	W.	0322	6·7	1034	2·6
7	W.	0042	6·6	0656	1·6	7	F.	0117	7·1	0727	1·6	7	M.	0230	7·5	0840	1·5	7	Th.	0316	7·9	0939	1·7	7	S.	0324	7·6	0954	1·9	7	Tu.	0349	6·9	1058	3·1	7	Th.	0350	6·1	1118	3·1
8	Th.	0128	6·4	0738	1·4	8	S.	0201	7·2	0808	1·4	8	Tu.	0309	7·7	0918	1·4	8	F.	0349	7·5	1015	2·4	8	S.	0347	6·9	1034	2·7	8	W.	0406	5·8	—	—	8	F.	0423	5·6	—	—
9	F.	0221	6·2	0821	1·3	9	S.	0243	7·2	0848	1·2	9	W.	0345	7·4	0956	1·4	9	S.	0422	6·7	1059	3·1	9	M.	0409	6·1	1126	3·5	9	Th.	0722	5·2	0056	4·9	9	S.	0635	5·2	0132	4·3
10	S.	0324	6·0	0926	1·4	10	M.	0324	7·2	0926	1·2	10	Th.	0425	7·4	1037	1·4	10	S.	0505	6·4	1205	3·8	10	Tu.	0448	5·5	—	—	10	F.	0922	5·3	0350	4·5	10	S.	0845	5·4	0325	4·3
11	S.	0324	6·5	0926	2·8	11	Tu.	0408	6·9	1010	3·0	11	F.	0515	6·5	1129	3·6	11	M.	0735	5·6	—	—	11	W.	0905	5·4	0254	4·7	11	S.	0955	5·9	0434	4·6	11	M.	0940	5·6	0416	3·8
12	M.	0412	6·1	1000	3·4	12	W.	0501	6·5	1058	3·6	12	S.	0639	6·1	—	—	12	Tu.	0830	5·8	0256	4·4	12	Th.	0946	5·6	0435	4·1	12	S.	2236	6·7	2622	3·1	12	Tu.	2216	6·9	1549	3·1
13	Tu.	0526	5·9	1108	4·0	13	Th.	0617	6·2	—	—	13	S.	0831	6·0	0054	3·6	13	W.	0926	6·3	0438	3·9	13	F.	1042	6·3	0508	3·6	13	M.	2302	7·2	2654	2·8	13	W.	2301	7·2	2635	2·8
14	W.	0721	5·9	0013	2·6	14	F.	0755	6·4	0037	3·0	14	M.	0945	6·4	0257	3·9	14	Th.	1105	6·6	0521	3·4	14	S.	1220	6·6	0536	3·1	14	Tu.	2331	7·5	2726	2·4	14	Th.	2325	7·5	2720	2·5
15	Th.	0844	6·4	0127	2·0	15	S.	0907	6·6	0154	3·2	15	Tu.	1035	6·9	0429	3·7																								

STRAITS SETTLEMENTS—PENANG, 1944. Lat. 5° 25′ N. Long. 100° 21′ E

Time meridian 110° E. (07h 20m fast); 00h is midnight 12h is noon. Heights are referred to the datum of the largest scale Admiralty chart of the place and should be *added* to depths, unless preceded by an asterisk (*), when they should be *subtracted*. To find height at times between high and low water *see* Table I.

TABLE III - 8c

JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER					NOVEMBER					DECEMBER				
Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low	
	Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.
	h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.
1 Th	2 16	3.5	8 23	1.9	1 Sa	1 56	3.9	8 24	1.7	1 Tu	3 03	4.4	9 54	0.9	1 F	4 33	5.4	11 06	−0.2	1 Su	5 01	5.8	11 22	−0.6	1 M	5 58	5.7	. ..	. .	1 W	6 35	4.9	0 20	−0.8
2 F	3 06	4.0	9 20	1.4	2 Su	2 52	4.2	9 27	1.2	2 W	3 57	5.0	10 43	0.4	2 Sa	5 15	5.9	11 45	−0.6	2 M	5 41	6.1	11 56	−0.8	2 Tu	6 38	5.5	0 35	−1.0	2 Th	7 02	4.7	1 02	−0.7
3 Sa	3 52	4.5	10 02	0.9	3 M	3 39	4.7	10 15	0.7	3 Th	4 43	5.5	11 24	−0.1	3 Su	5 56	5.3	. ..	. .	3 Tu	6 18	6.2	. ..	. .	3 W	7 14	5.2	1 12	−0.9	3 F	7 38	4.4	1 46	−0.5
4 Su	4 35	4.9	10 38	0.5	4 Tu	4 20	5.2	10 55	0.2	4 F	5 25	6.0	12 02	−0.5	4 M	6 34	5.4	0 22	−0.7	4 W	6 55	6.0	0 47	−1.1	4 Th	7 50	4.7	1 50	−0.8	4 Sa	8 15	4.1	2 17	−0.2
5 M	5 16	5.3	11 12	0.0	5 W	4 57	5.6	11 34	−0.2	5 Sa	6 05	6.3	. ..	. .	5 Tu	7 12	5.3	1 01	−0.6	5 Th	7 32	5.7	1 25	−1.0	5 F	8 29	4.2	2 29	−0.2	5 Su	8 57	3.8	2 56	0.2
6 Tu	5 57	5.7	11 45	0.3	6 Th	5 34	6.0	12 11	−0.5	6 Su	6 45	6.5	0 31	−0.3	6 M	7 50	5.0	1 40	−0.8	6 F	8 08	5.1	2 03	−0.7	6 Sa	9 10	3.7	3 11	0.4	6 M	9 45	3.5	3 40	0.6
7 W	6 39	6.0	. ..	. .	7 F	6 13	6.3	. ..	. .	7 M	7 26	6.4	1 11	−0.4	7 Tu	8 29	5.5	2 20	−0.5	7 Sa	8 40	4.5	2 43	−0.2	7 Su	10 05	3.2	4 01	0.9	7 Tu	10 47	3.2	4 32	1.0
8 Th	7 23	6.2	0 07	0.1	8 Sa	6 52	6.4	0 35	0.0	8 Tu	8 07	6.1	1 52	−0.4	8 W	9 09	4.8	3 01	−0.1	8 Su	9 20	3.9	3 27	0.4	8 M	10 56	2.9	5 14	1.3	8 W	11 57	3.3	5 37	1.3
9 F	8 08	6.3	0 41	0.1	9 Su	7 33	6.3	1 16	0.0	9 W	8 48	5.7	2 35	−0.2	9 Th	9 54	4.1	3 50	0.5	9 M	10 22	3.2	4 22	1.1	9 Tu	12 06	3.1	6 29	1.7	9 Th	0 03	3.6	6 56	1.4
10 Sa	8 56	6.3	1 20	0.2	10 M	8 17	6.0	2 00	0.1	10 Th	9 34	5.0	3 22	0.2	10 F	10 53	3.4	4 53	1.1	10 Tu	1 30	3.0	5 57	1.5	10 W	1 21	3.5	8 07	1.3	10 F	1 21	3.5	8 07	1.3
11 Su	9 48	5.8	2 02	0.4	11 Tu	9 05	5.6	2 47	0.3	11 F	10 27	4.3	4 17	0.7	11 Sa	. ..	. .	6 36	1.5	11 W	0 37	3.6	8 12	1.5	11 Th	2 43	3.8	9 16	1.0	11 F	2 44	3.7	9 04	1.1
12 M	10 46	5.3	2 51	0.7	12 W	10 00	5.0	3 40	0.6	12 Sa	11 35	3.6	5 20	1.2	12 Su	1 18	3.9	8 47	1.4	12 Th	2 25	3.8	9 26	1.1	12 Sa	3 34	4.1	9 52	0.7	12 Sa	3 26	3.9	9 46	0.9
13 Tu	11 56	4.9	3 52	1.1	13 Th	11 06	4.4	4 47	1.0	13 Su	9 23	4.2	7 15	1.4	13 M	2 59	4.2	9 59	0.9	13 F	3 33	4.2	10 07	0.7	13 Su	4 16	4.4	10 25	0.4	13 M	4 20	4.1	10 14	0.7
14 W	. ..	. .	5 14	1.4	14 F	12 21	3.9	6 13	1.2	14 M	1 56	4.2	9 01	1.2	14 Tu	4 00	4.6	10 40	0.5	14 Sa	4 15	4.5	10 38	0.4	14 M	4 49	4.7	10 52	0.2	14 Tu	4 57	4.3	10 48	0.5
15 Th	0 48	3.9	6 56	1.4	15 Sa	13 53	3.7	7 52	1.2	15 Tu	3 18	4.5	10 11	0.8	15 W	4 42	5.0	11 13	0.2	15 Su	4 50	4.8	11 06	0.1	15 Tu	5 21	4.8	11 20	0.1	15 W	5 33	4.4	11 18	0.4
16 F	2 06	4.3	8 25	1.0	16 Su	15 15	3.7	21 10	1.0	16 W	4 15	4.9	10 57	0.4	16 Th	5 17	5.3	11 41	−0.1	16 M	5 21	5.2	11 39	−0.1	16 W	5 58	4.9	11 46	0.0	16 Th	6 06	4.5	0 09	−0.3
17 Sa	3 07	4.8	9 33	0.5	17 M	3 36	5.0	10 18	0.5	17 Th	5 00	5.3	11 34	0.0	17 F	5 47	5.6	. ..	. .	17 Tu	5 48	5.3	11 56	−0.2	17 Th	6 32	4.8	0 04	−0.4	17 F	6 42	4.5	0 43	−0.6
18 Su	3 57	5.3	10 37	0.1	18 Tu	4 26	5.3	11 06	0.1	18 F	5 34	5.6	12 06	−0.2	18 Sa	6 15	5.7	0 09	0.0	18 W	6 16	5.3	. ..	. .	18 F	6 55	4.7	0 55	−0.5	18 Sa	7 18	4.5	1 20	−0.6
19 M	4 41	5.7	11 12	−0.2	19 W	5 09	5.6	11 47	−0.2	19 Sa	6 07	5.7	. ..	. .	19 Su	6 41	5.6	0 37	−0.2	19 Th	6 44	5.3	0 13	−0.3	19 Sa	7 24	4.6	1 31	−0.5	19 Su	8 00	4.4	1 56	−0.5
20 Tu	5 21	6.0	11 54	−0.5	20 Th	5 46	5.8	. ..	. .	20 Su	6 36	5.8	0 27	0.1	20 M	7 06	5.5	1 04	−0.3	20 F	7 12	5.0	1 11	−0.5	20 Su	8 03	4.3	2 05	−0.3	20 M	8 42	4.3	2 40	−0.3
21 W	5 57	6.1	. ..	. .	21 F	6 21	5.9	0 05	0.4	21 M	7 04	5.8	0 57	0.0	21 Tu	7 35	5.3	1 32	−0.3	21 Sa	7 42	4.8	1 42	−0.3	21 M	8 48	3.8	2 48	0.0	21 Tu	9 26	4.1	3 26	0.0
22 Th	6 32	6.1	0 15	0.3	22 Sa	6 51	5.9	0 30	0.3	22 Tu	7 33	5.6	1 26	0.0	22 W	8 04	4.9	2 01	−0.1	22 Su	8 15	4.4	2 17	−0.1	22 Tu	9 45	3.6	3 40	0.4	22 W	10 26	4.0	4 04	0.4
23 F	7 04	6.0	0 46	0.4	23 Su	7 23	5.8	1 11	0.3	23 W	8 01	5.3	1 55	0.1	23 Th	8 34	4.5	2 34	0.2	23 M	8 50	3.9	2 56	0.3	23 W	11 04	3.4	4 48	0.8	23 Th	11 34	4.0	4 52	0.7
24 Sa	7 34	5.8	1 43	0.4	24 M	7 54	5.5	1 53	0.4	24 Th	8 31	5.0	2 25	0.3	24 F	9 11	4.0	3 12	0.5	24 Tu	9 50	3.4	3 48	0.7	24 Th	. ..	. .	6 15	0.8	24 F	. ..	. .	5 30	0.7
25 Su	8 11	5.4	2 16	0.6	25 Tu	8 26	5.2	2 36	0.6	25 F	9 02	4.5	2 59	0.6	25 Sa	10 00	3.4	4 02	1.0	25 W	11 20	3.1	5 06	1.1	25 F	12 30	3.6	7 42	0.8	25 Sa	0 15	4.3	6 42	0.6
26 M	8 48	5.0	2 31	1.0	26 W	9 00	4.8	3 01	0.8	26 Sa	9 36	4.0	3 39	0.9	26 Su	11 28	2.9	5 20	1.4	26 Th	. ..	. .	6 56	1.2	26 Sa	0 52	4.3	8 49	0.6	26 Su	1 45	4.1	8 04	0.7
27 Tu	9 27	4.5	3 16	1.3	27 Th	9 36	4.4	3 36	1.1	27 Su	10 29	3.4	4 32	1.3	27 M	0 02	4.0	7 36	1.4	27 F	1 32	4.2	8 31	0.9	27 Su	2 28	4.7	9 43	0.3	27 M	3 00	4.3	9 38	0.5
28 W	10 16	4.1	4 02	1.7	28 F	10 26	3.9	4 19	1.4	28 M	. ..	. .	5 02	1.5	28 Tu	2 02	4.2	9 09	0.9	28 Sa	2 57	4.6	9 30	0.4	28 M	4 21	4.9	10 37	0.1	28 Tu	4 03	4.5	10 44	0.3
29 Th	11 26	3.7	5 14	1.9	29 Sa	11 36	3.6	5 27	1.7	29 Tu	0 50	3.9	6 14	1.5	29 W	3 23	4.7	10 04	0.4	29 Su	3 55	5.1	10 15	0.0	29 Tu	5 05	5.1	11 24	−0.1	29 W	5 38	4.5	11 34	0.3
30 F	0 44	3.6	6 54	2.0	30 Su	0 23	3.8	7 12	1.8	30 W	2 32	4.3	9 37	1.0	30 Th	4 17	5.3	10 45	−0.2	30 M	4 41	5.4	10 52	−0.3	30 W	5 47	5.1	11 40	−0.2	30 Th	6 18	4.6	0 17	−0.6
	12 46	3.4	19 15	1.4	31 M	1 54	4.0	8 48	1.4	31 Th	3 41	4.8	10 38	0.4						31 Tu	5 22	5.7	11 29	−0.5						31 F	6 59	4.5	12 02	0.2
						14 44	3.3	20 29	1.6		15 32	3.9	22 17	0.9						17 27	6.1	23 56	−0.9										

DAVAO, PHILIPPINE ISLANDS, 1944

Time meridian 120° E. The hours of the day are numbered consecutively from 0h (midnight) to 23h (11 00 p. m.). 12h is noon. All hours greater than 12 are in the afternoon (p. m.).

Height are reckoned from the datum of soundings on charts of the locality which is mean lower low water.

TABLE III - 8f

JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER					NOVEMBER					DECEMBER				
Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low		Day	High		Low	
	Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.		Time	Ht.	Time	Ht.
	h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.		h. m.	ft.	h. m.	ft.
1	. ..	..	0 35	0.5	1	6 40	2.6	1 49	1.5	1	6 45	3.7	.. ..	..	1	8 03	4.4	.. ..	..	1	8 47	5.9	1 49	1.6	1	10 48	2.3	4 42	0.3	1	.. ..	..	5 57	-0.7
Th	5 06	2.3	.. ..	..	Sa	5 59	1.8	11 44	1.3	Tu	.. ..	..	3 32	0.5	F	.. ..	..	4 25	-0.1	Su	10 22	2.0	4 27	0.4	M	10 17	3.3	4 03	1.2	F	10 31	3.6	.. ..	..
2	8 02	2.2	1 00	0.7	2	7 02	3.0	2 55	1.1	2	7 30	4.1	.. ..	..	2	8 56	4.6	.. ..	..	2	9 46	5.8	3 06	1.3	2	11 55	1.9	5 42	-0.1	2	.. ..	..	6 49	-0.8
F	6 34	2.0	1 52	1.6	Su	7 50	1.8	11 56	1.4	W	.. ..	..	4 18	0.1	Sa	11 21	1.7	5 15	-0.1	M	10 40	2.3	4 56	0.6	Tu	10 49	3.7	4 13	1.4	Sa	11 00	4.0	.. ..	..
3	8 10	2.5	1 16	0.9	3	7 33	3.4	.. ..	..	3	8 21	4.5	.. ..	..	3	9 52	4.6	2 29	1.6	3	10 44	3.4	4 15	0.9	3	1 11	1.8	6 40	-0.3	3	.. ..	..	7 39	-0.8
Sa	7 05	1.8	2 58	1.1	M	.. ..	..	3 45	0.6	Su	.. ..	..	5 01	-0.2	Su	11 42	1.8	5 49	0.1	Tu	11 02	2.7	5 18	1.0	F	11 25	2.9	4 17	1.4	Su	11 28	3.9	.. ..	..
4	8 22	2.8	1 34	1.1	4	8 07	3.8	.. ..	..	4	9 10	4.7	.. ..	..	4	10 46	4.4	3 40	1.4	4	11 41	3.0	5 20	0.6	4	.. ..	..	7 41	-0.4	4	.. ..	..	8 29	-0.8
Su	9 14	1.7	3 48	0.7	Tu	.. ..	..	4 31	0.2	M	11 50	2.1	6 21	0.4	M	11 50	2.1	6 21	0.4	W	11 31-	3.1	5 36	1.3	Sa	.. ..	..	.. ..	..	M	.. ..	..	.. ..	..
5	8 46	3.2	1 51	1.2	5	8 45	4.2	.. ..	..	5	10 00	4.9	.. ..	..	5	11 37	4.0	4 49	1.2	5	.. ..	..	6 24	0.4	5	0 02	3.9	8 40	-0.4	5	0 18	3.7	9 20	-0.6
M	10 36	1.5	4 34	0.3	W	.. ..	..	5 16	-0.2	Sa	.. ..	..	6 25	-0.3	Tu	.. ..	..	6 48	0.8	Th	12 40	2.5	6 49	1.5	Su	.. ..	..	.. ..	..	Tu	.. ..	..	.. ..	..
6	9 16	3.6	2 07	1.3	6	9 27	4.5	.. ..	..	6	10 50	4.8	.. ..	..	6	0 27	2.4	6 00	1.1	6	0 03	3.5	7 32	0.3	6	0 41	3.8	9 48	-0.3	6	0 56	3.4	10 08	-0.4
Tu	.. ..	..	5 18	0.0	Th	.. ..	..	6 02	-0.4	Su	.. ..	..	7 06	-0.2	W	12 31	3.5	7 09	1.2	F	1 51	2.0	8 54	1.6	M	.. ..	..	.. ..	..	W	.. ..	..	.. ..	..
7	9 48	4.0	.. ..	..	7	10 08	4.7	.. ..	..	7	11 38	4.6	.. ..	..	7	0 57	2.8	7 12	1.0	7	0 38	3.7	8 43	0.3	7	1 22	3.6	10 52	-0.2	7	1 40	3.0	10 55	-0.2
W	.. ..	..	6 04	-0.3	F	.. ..	..	6 46	-0.6	M	.. ..	..	7 41	0.1	Th	1 30	2.9	7 55	1.5	Sa	.. ..	..	.. ..	..	Tu	.. ..	..	.. ..	..	Th	.. ..	..	.. ..	..
8	10 22	4.2	.. ..	..	8	10 52	4.8	.. ..	..	8	1 46	1.7	5 36	1.5	8	1 31	3.1	8 36	1.0	8	1 19	3.8	10 04	0.3	8	2 09	3.3	11 54	0.0	8	2 29	2.6	11 35	0.0
Th	.. ..	..	6 52	-0.5	Sa	.. ..	..	7 31	-0.6	Tu	12 28	4.8	8 13	0.5	F	2 25	2.2	7 28	1.7	Su	.. ..	..	.. ..	..	W	.. ..	..	.. ..	..	F	.. ..	..	.. ..	..
9	11 01	4.4	.. ..	..	9	11 39	4.7	.. ..	..	9	2 12	2.0	6 37	1.5	9	2 11	3.4	10 11	0.9	9	2 03	3.7	11 30	0.3	9	3 13	3.0	.. ..	..	9	3 26	2.2	.. ..	..
F	.. ..	..	7 43	-0.5	Su	.. ..	..	8 17	-0.4	W	1 20	2.6	8 58	0.8	Su	.. ..	..	.. ..	..	M	.. ..	..	.. ..	..	Th	.. ..	..	.. ..	..	Su	0 05	1.7	12 08	0.2
10	11 41	4.4	.. ..	..	10	2 46	2.4	8 07	1.5	10	2 56	3.6	11 59	0.8	10	2 59	3.6	.. ..	..	10	2 59	3.6	.. ..	..	10	4 25	2.7	.. ..	..	10	4 31	1.8	0 13	1.6
Sa	.. ..	..	8 37	-0.6	M	12 26	4.4	9 00	-0.2	Tu	2 17	2.8	8 58	1.3	Su	.. ..	..	.. ..	..	Tu	.. ..	..	12 46	0.3	F	.. ..	..	1 26	0.2	M	7 44	1.8	12 30	0.4
11	.. ..	..	9 31	-0.5	11	.. ..	..	.. ..	..	11	3 25	2.8	9 55	1.5	11	3 52	3.6	.. ..	..	11	4 07	3.4	.. ..	..	11	5 45	2.4	.. ..	..	11	6 07	1.5	1 39	1.3
Su	12 29	4.3	.. ..	..	Tu	1 18	4.0	9 40	0.2	F	3 20	2.3	9 07	1.5	M	.. ..	..	1 20	0.6	W	.. ..	..	1 40	0.3	Sa	9 00	1.9	1 56	0.5	M	7 48	2.2	12 44	0.6
12	.. ..	..	.. ..	..	12	.. ..	..	.. ..	..	12	4 08	3.2	12 10	1.3	12	5 00	3.7	.. ..	..	12	5 25	3.2	.. ..	..	12	6 58	2.2	1 50	1.6	12	7 40	1.3	3 02	0.8
M	1 20	4.0	10 23	-0.3	W	2 14	3.4	10 13	0.6	Sa	5 12	1.7	9 00	1.5	Tu	.. ..	..	2 42	0.5	Th	.. ..	..	2 36	0.4	Su	8 52	2.1	2 53	0.7	Tu	8 07	2.5	12 58	0.8
13	.. ..	..	.. ..	..	13	5 03	2.2	9 17	1.9	13	4 59	3.5	.. ..	..	13	6 10	3.7	.. ..	..	13	6 39	3.1	.. ..	..	13	8 09	2.0	2 54	1.3	13	9 05	1.1	3 51	0.4
Tu	2 16	3.6	11 09	0.0	Th	3 15	2.8	10 36	1.0	Su	.. ..	...	2 02	0.9	W	.. ..	..	3 28	0.4	F	.. ..	..	3 00	0.5	M	9 01	2.4	3 54	0.9	W	9 28	2.0	1 00	0.9
14	.. ..	..	.. ..	..	14	5 28	2.6	11 48	1.7	14	5 52	3.7	.. ..	..	14	7 14	3.7	.. ..	..	14	7 41	3.0	.. ..	..	14	9 05	1.8	3 41	0.9	14	10 22	1.0	4 39	0.0
W	3 22	3.1	11 47	0.3	F	4 30	2.1	10 52	1.2	M	.. ..	..	3 11	0.6	Th	.. ..	..	4 05	0.4	Sa	9 57	2.0	3 24	0.8	Tu	9 15	2.7	3 47	1.0	Th	9 57	2.5	1 52	0.9
15	7 09	2.0	11 01	1.9	15	6 46	3.9	.. ..	..	15	6 48	3.9	.. ..	..	15	8 11	3.7	.. ..	..	15	8 35	2.9	2 30	1.7	15	10 04	1.7	4 26	0.5	15	.. ..	..	5 12	-0.4
Th	4 41	2.6	.. ..	..	Sa	6 31	1.6	10 56	1.4	Tu	.. ..	..	3 58	0.4	F	.. ..	..	4 32	0.5	Su	9 58	2.2	3 54	0.8	W	9 35	3.0	3 00	1.1	F	9 31	3.5	.. ..	..
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F	5 11	2.1	1 19	1.5	Su	.. ..	..	2 14	0.8	W	.. ..	..	4 28	0.3	Sa	11 06	1.9	4 57	0.6	M	10 06	2.4	4 10	1.0	Th	10 00	2.3	3 06	1.2	Sa	10 05	3.8	.. ..	..
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Sa	7 06	1.7	2 52	1.0	M	.. ..	..	4 09	0.4	Th	.. ..	..	5 12	0.2	Su	11 06	2.1	5 18	0.7	Tu	10 22	2.6	4 23	1.2	F	10 20	2.5	3 16	1.2	Su	10 42	3.9	.. ..	..
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Su	9 38	1.5	3 54	0.5	Tu	.. ..	..	4 54	0.1	F	.. ..	..	5 42	0.3	M	11 21	2.2	5 36	0.9	W	10 41	2.9	4 32	1.3	Sa	11 02	2.7	.. ..	..	M	11 26	4.0	.. ..	..
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Tu	.. ..	..	5 34	-0.2	Th	.. ..	..	6 09	-0.1	Su	.. ..	..	6 34	0.5	W	11 54	2.7	6 06	1.3	F	11 30	3.4	4 51	1.5	M	.. ..	..	.. ..	..	W	.. ..	..	.. ..	..
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W	.. ..	..	6 19	-0.3	F	.. ..	..	6 43	0.0	M	11 08	3.8	6 58	0.7	Th	12 21	2.7	6 16	1.5	Sa	1 30	1.7	4 52	1.5	Tu	.. ..	..	.. ..	..	Th	.. ..	..	.. ..	..
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F	.. ..	..	7 42	-0.3	Sa	.. ..	..	7 48	0.2	W	12 25	3.3	7 35	1.1	Sa	2 08	2.0	6 54	1.7	M	.. ..	..	.. ..	..	Tu	.. ..	..	.. ..	..	Sa	6 36	1.4	9 57	1.3
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Sa	.. ..	..	8 35	-0.2	Su	.. ..	..	8 18	0.4	Th	1 02	3.0	7 49	1.3	Su	.. ..	..	.. ..	..	Tu	.. ..	..	.. ..	..	W	.. ..	..	12 06	-0.3	Su	6 40	1.8	.. ..	..
25	12 08	4.0	9 05	0.0	25	12 31	3.7	8 44	0.8	F	1 54	2.6	7 52	1.8	25	1 59	3.5	10 53	0.8	25	2 15	3.7	11 52	0.0	25	4 19	2.9	12 49	-0.1	25	5 33	1.6	0 31	1.0
M	.. ..	..	9 43	0.2	M	1 06	3.3	9 05	0.9	Sa	2 48	2.5	8 02	1.8	M	.. ..	..	.. ..	..	W	.. ..	..	.. ..	..	Th	8 17	1.7	11 43	1.6	M	7 04	2.3	12 06	0.4
26	12 45	3.7	9 43	0.2	26	1 40	3.3	9 05	0.9	Su	2 28	2.8	9 16	1.5	26	2 53	3.6	12 28	0.5	26	3 24	3.6	.. ..	..	26	5 46	2.5	.. ..	..	26	7 15	1.2	2 18	0.5
Tu	1 24	3.4	10 18	0.4	W	1 51	2.9	9 33	1.1	M	3 08	3.1	9 43	1.4	Tu	.. ..	..	.. ..	..	Th	.. ..	..	12 58	-0.1	F	8 04	2.0	1 22	0.2	Tu	7 34	2.8	12 17	0.7
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W	1 56	3.4	10 48	0.7	Th	4 04	2.3	9 12	1.9	W	4 34	1.8	7 48	1.7	W	.. ..	..	1 24	0.3	F	.. ..	..	1 46	-0.1	Sa	8 19	2.4	1 46	0.5	W	9 08	3.2	12 25	0.8
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Th	2 07	3.0	10 46	0.7	F	2 36	2.5	9 36	1.3	Th	.. ..	..	12 55	1.0	F	.. ..	..	2 20	0.1	Su	9 11	3.0	2 25	0.1	M	9 42	2.9	2 04	0.6	Th	9 43	3.5	.. ..	..
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Th	3 03	2.6	11 10	0.9	Sa	3 50	2.0	9 45	1.5	Tu	.. ..	..	2 12	0.8	F	.. ..	..	3 14	0.0	M	9 12	3.1	2 50	0.3	Tu	9 12	3.4	2 19	1.0	F	9 33	3.7	.. ..	..
30	6 29	2.3	11 50	1.9	30	5 15	3.0	1 27	1.4	W	5 57	3.9	.. ..	..	30	7 43	4.0	.. ..	..	30	8 37	2.9	2 31	1.2	W	11 20	1.2	5 04	-0.4	30	.. ..	..	6 01	-1.0
F	4 18	2.2	11 26	1.1	Su	6 02	1.7	9 51	1.6	Th	.. ..	..	3 05	0.2	Sa	10 17	1.9	3 54	0.2	Tu	9 26	2.5	3 25	0.6	Th	9 43	3.7	2 38	1.1	Sa	10 01	3.8	.. ..	..
					31	5 57	3.4	.. ..	..											31	9 44	2.6	3 38	0.7						31	.. ..	..	6 43	-1.0
					M	.. ..	..	2 41	0.9											Tu	9 40	2.9	3 46	0.9						Su	10 43	3.8	.. ..	..

MANILA, PHILIPPINE ISLANDS, 1944

Time meridian 120° E. Heavy-faced type indicates p. m. tides. 0h is midnight, 12h is noon. Heights are reckoned from the datum of soundings on charts of the locality which is mean lower low water.

TABLE III - 8g

CEBU, PHILIPPINE ISLANDS, 1944

Time meridian 120° E. Heavy-faced type indicates p. m. tides. 0h is midnight, 12h is noon. Heights are reckoned from the datum of soundings on charts of the locality which is mean lower low water.

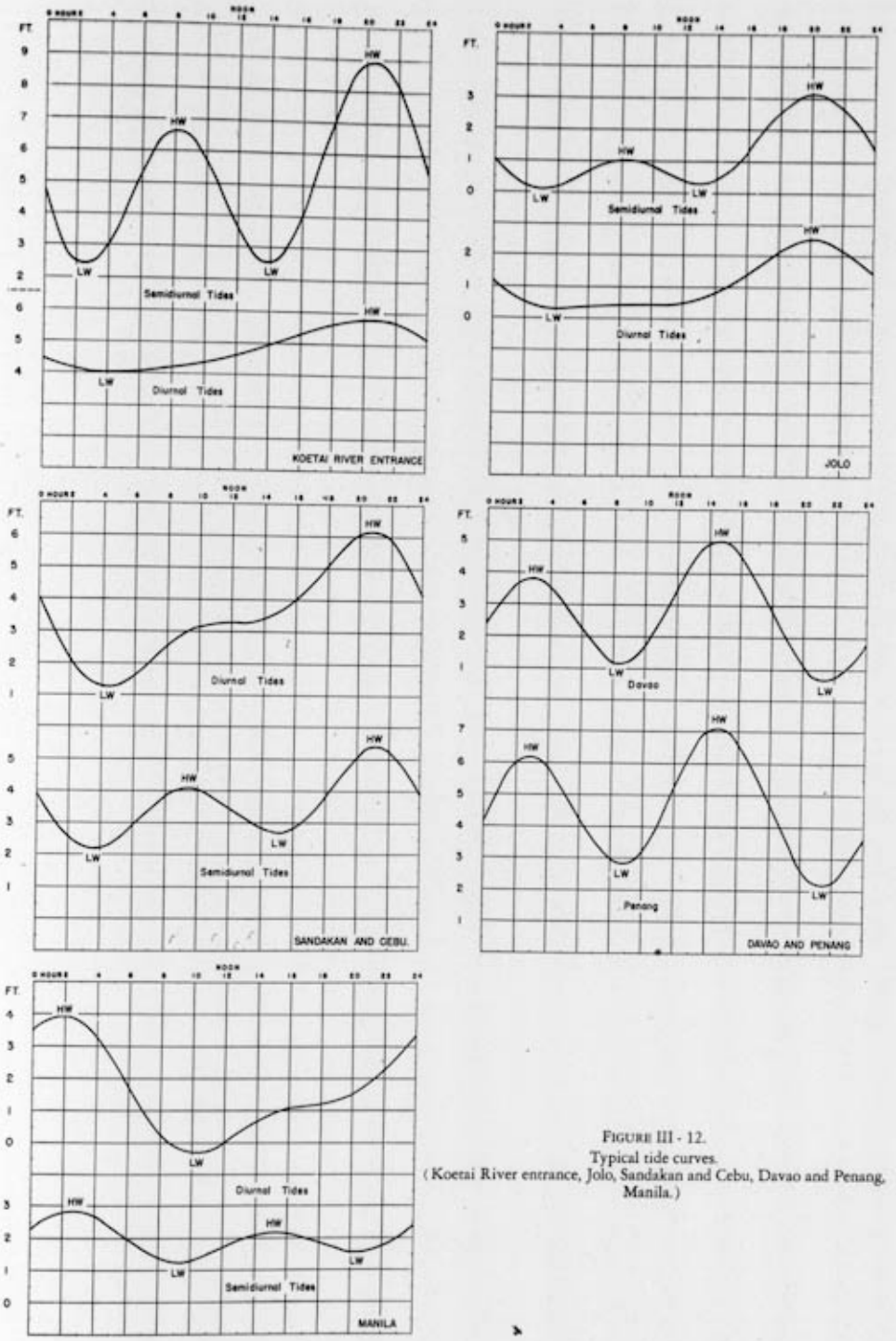

FIGURE III - 12.
Typical tide curves.
(Koetai River entrance, Jolo, Sandakan and Cebu, Davao and Penang, Manila.)

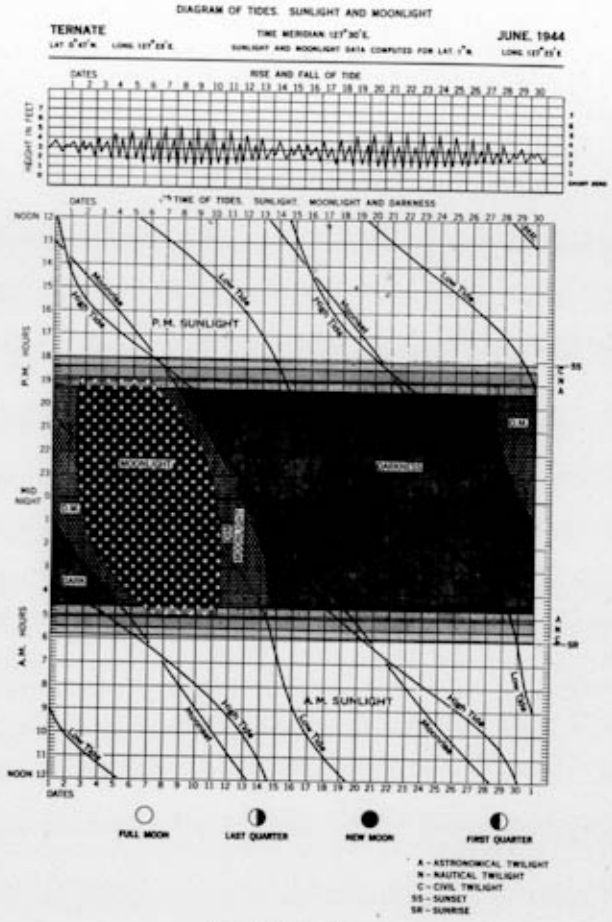

FIGURE III - 13. *Ternate.*
Tides, sunlight, and moonlight data, June 1944.

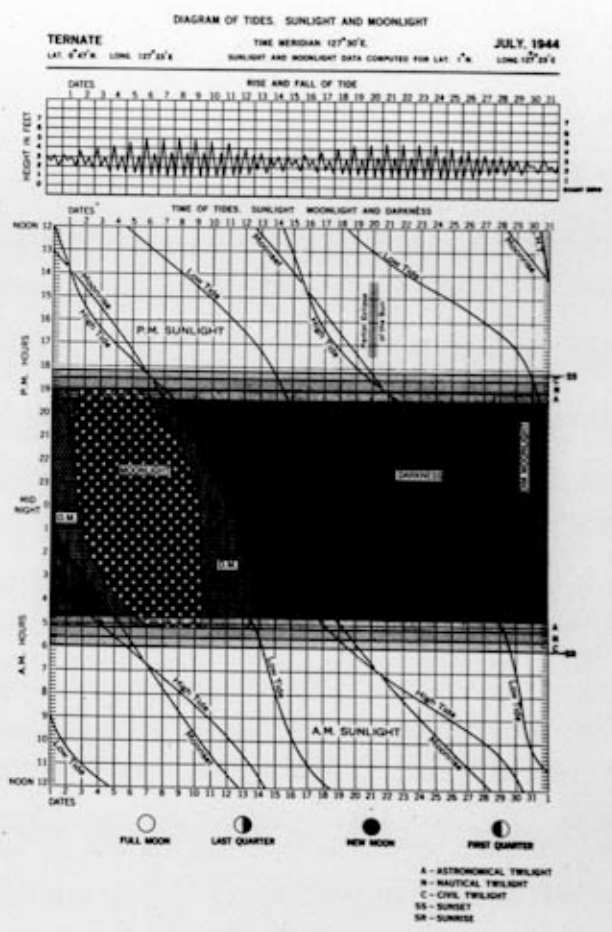

FIGURE III - 14. *Ternate.*
Tides, sunlight, and moonlight data, July 1944.

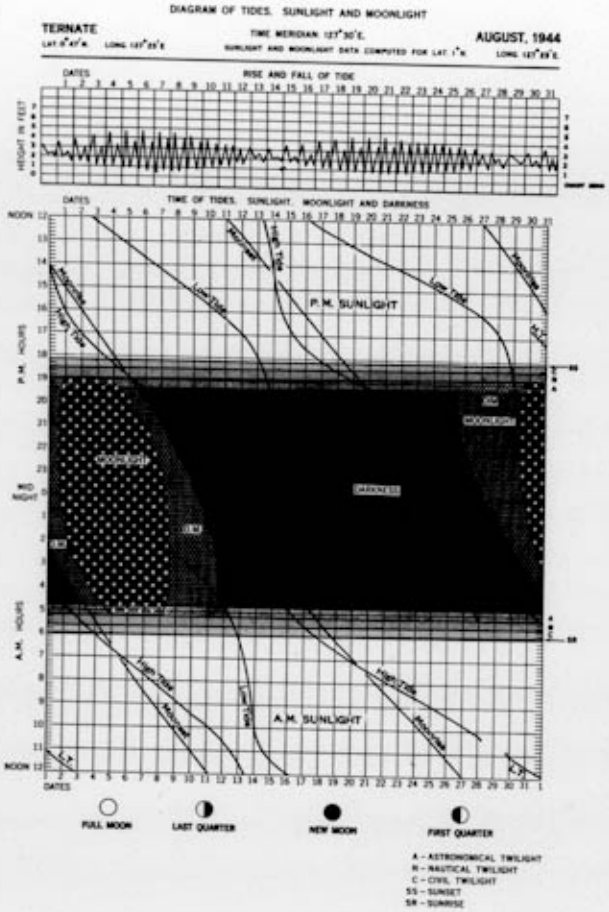

FIGURE III - 15. *Ternate*
Tides, sunlight, and moonlight data, August 1944.

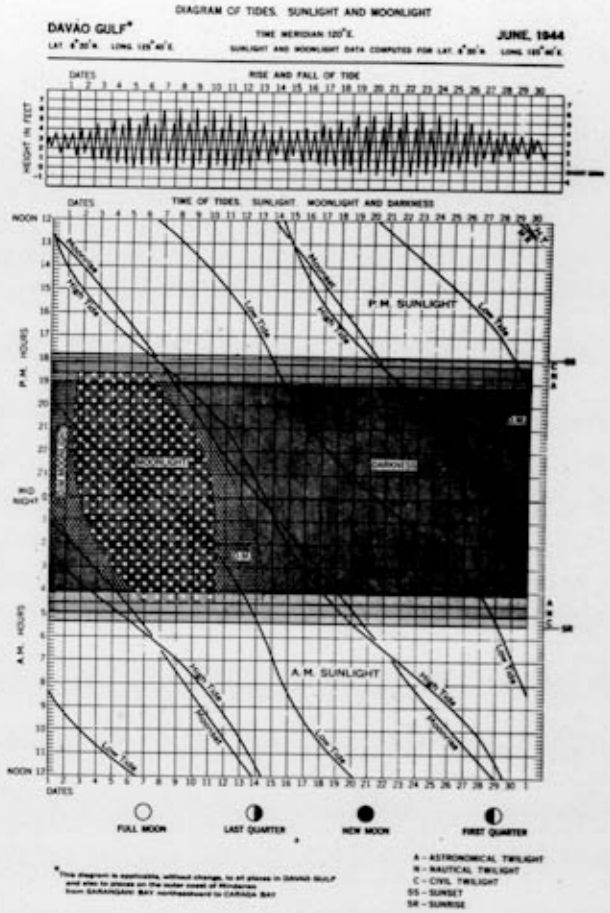

FIGURE III - 16. *Davao Gulf*
Tides, sunlight, and moonlight data, June 1944.

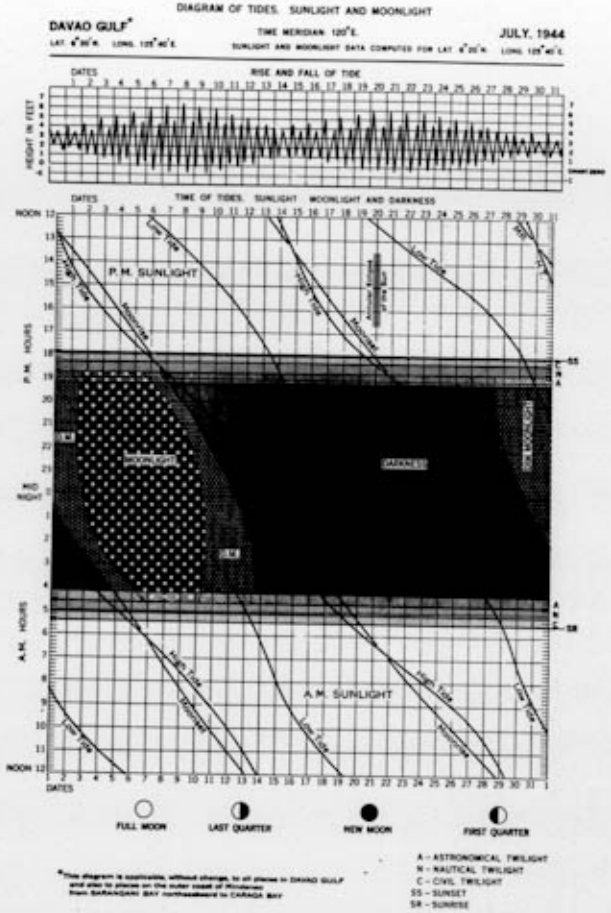

FIGURE III - 17. *Davao Gulf.*
Tides, sunlight, and moonlight data, July 1944.

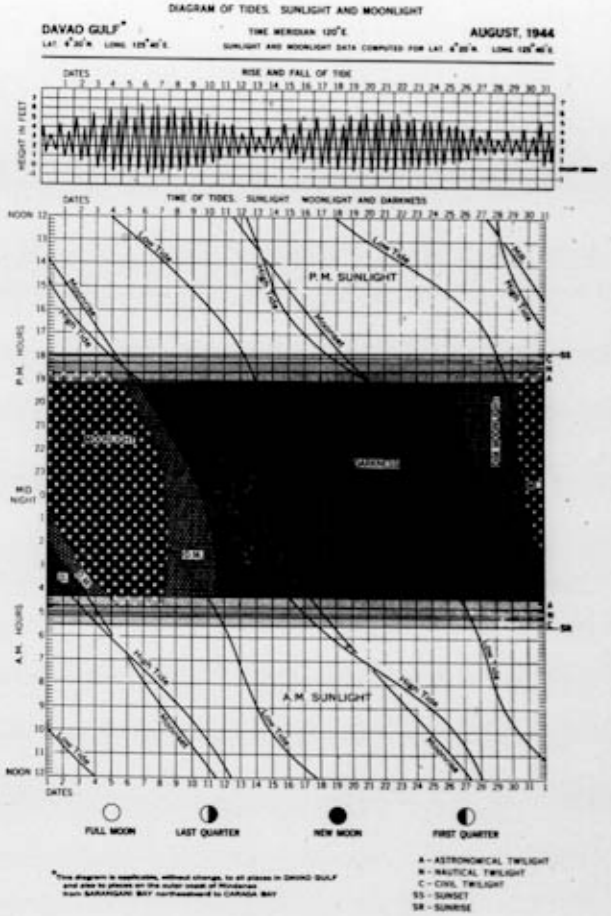

FIGURE III - 18. *Davao Gulf.*
Tides, sunlight, and moonlight data, August 1944.

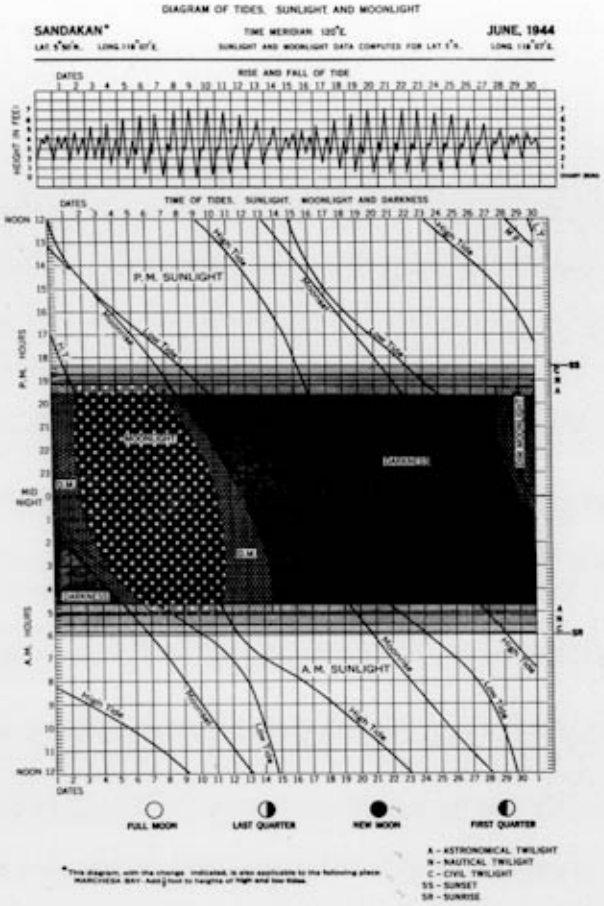

FIGURE III - 19. *Sandakan.*
Tides, sunlight, and moonlight data, June 1944.

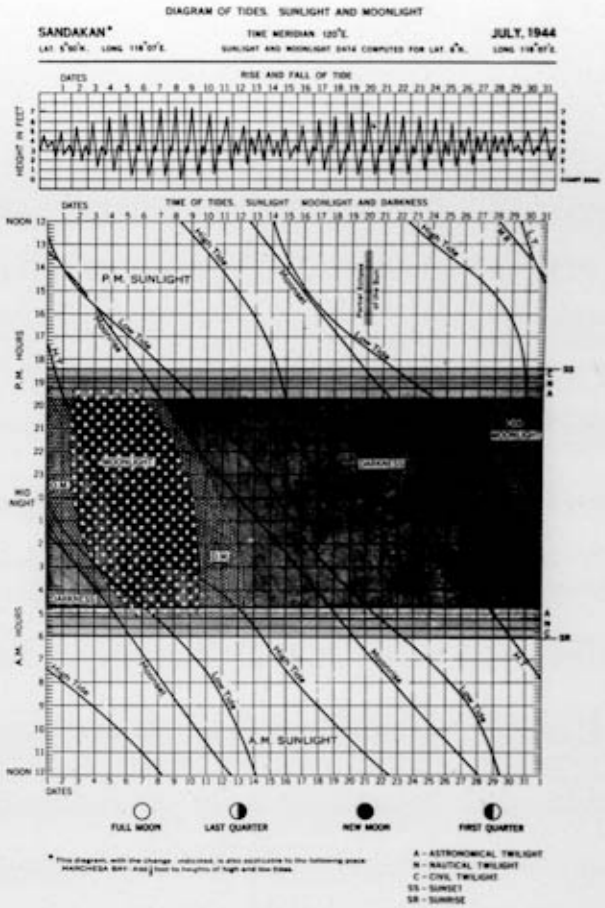

FIGURE III - 20. *Sandakan.*
Tides, sunlight, and moonlight data, July 1944.

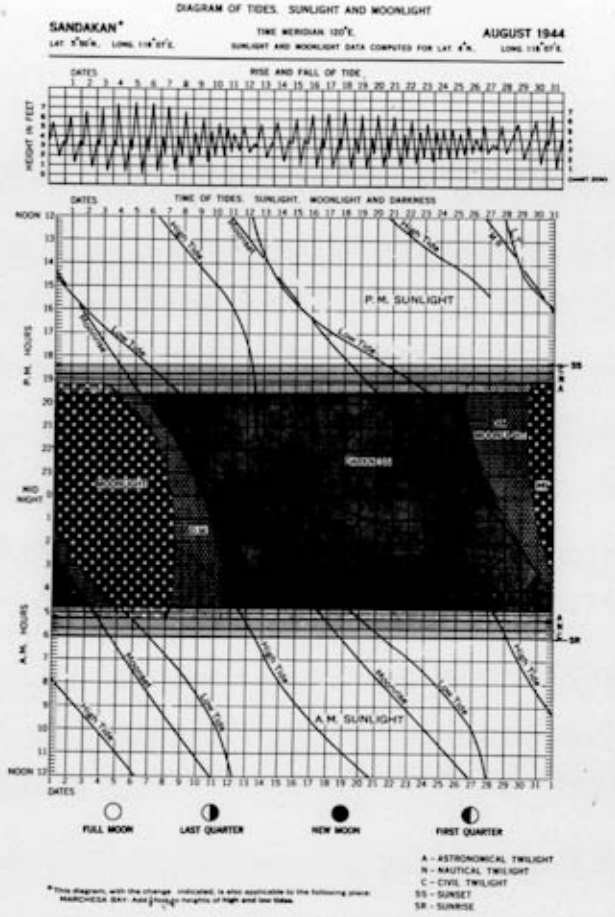

FIGURE III - 21. *Sandakan.*
Tides, sunlight, and moonlight data, August 1944.

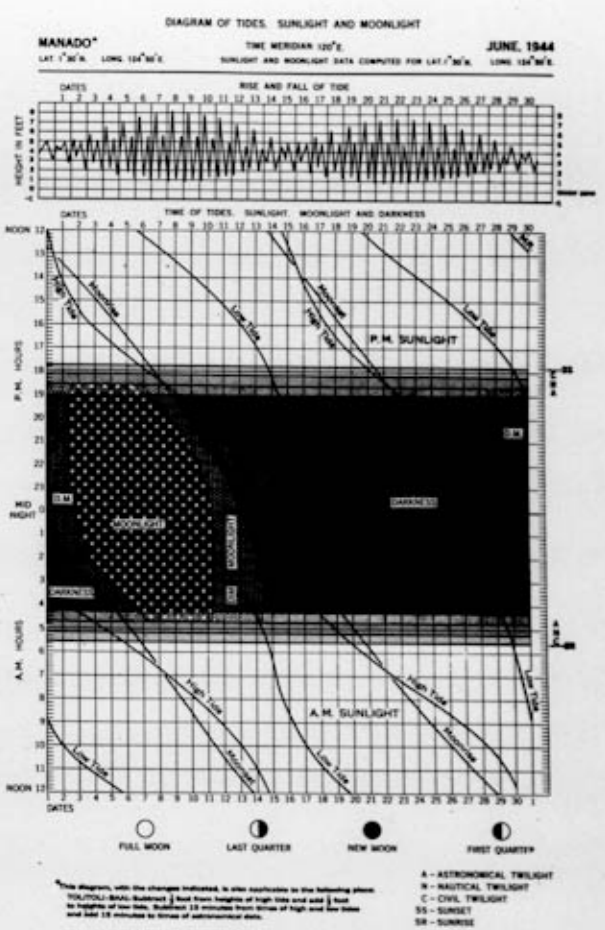

FIGURE III - 22. *Manado.*
Tides, sunlight, and moonlight data, June 1944.

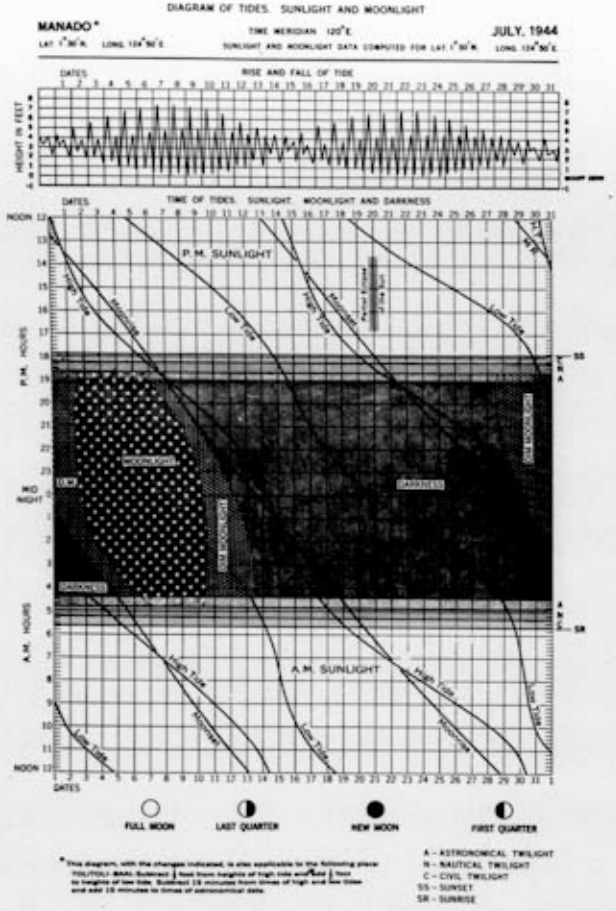

FIGURE III - 23. *Manado.*
Tides, sunlight, and moonlight data, July 1944.

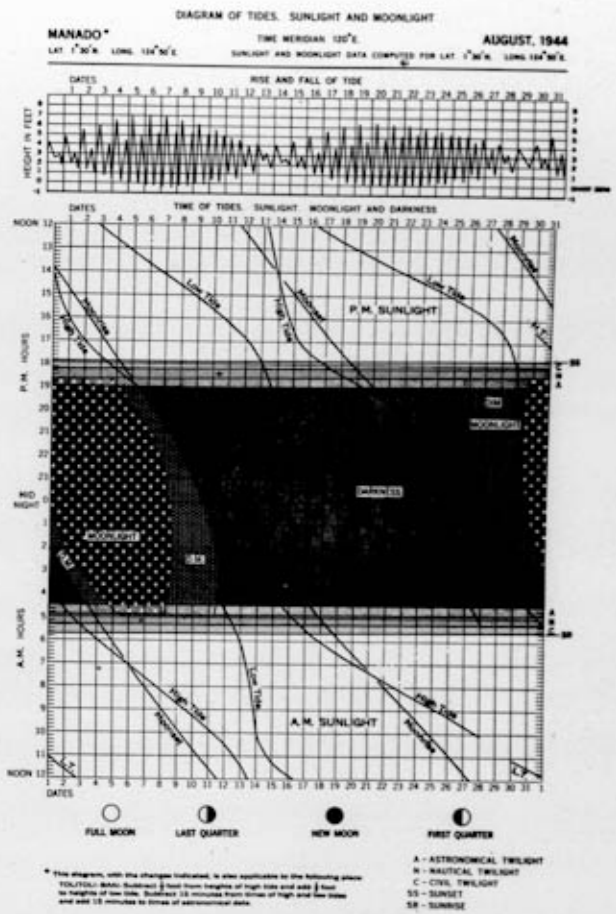

FIGURE III - 24. *Manado.*
Tides, sunlight, and moonlight data, August 1944.

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FIGURE III - 25
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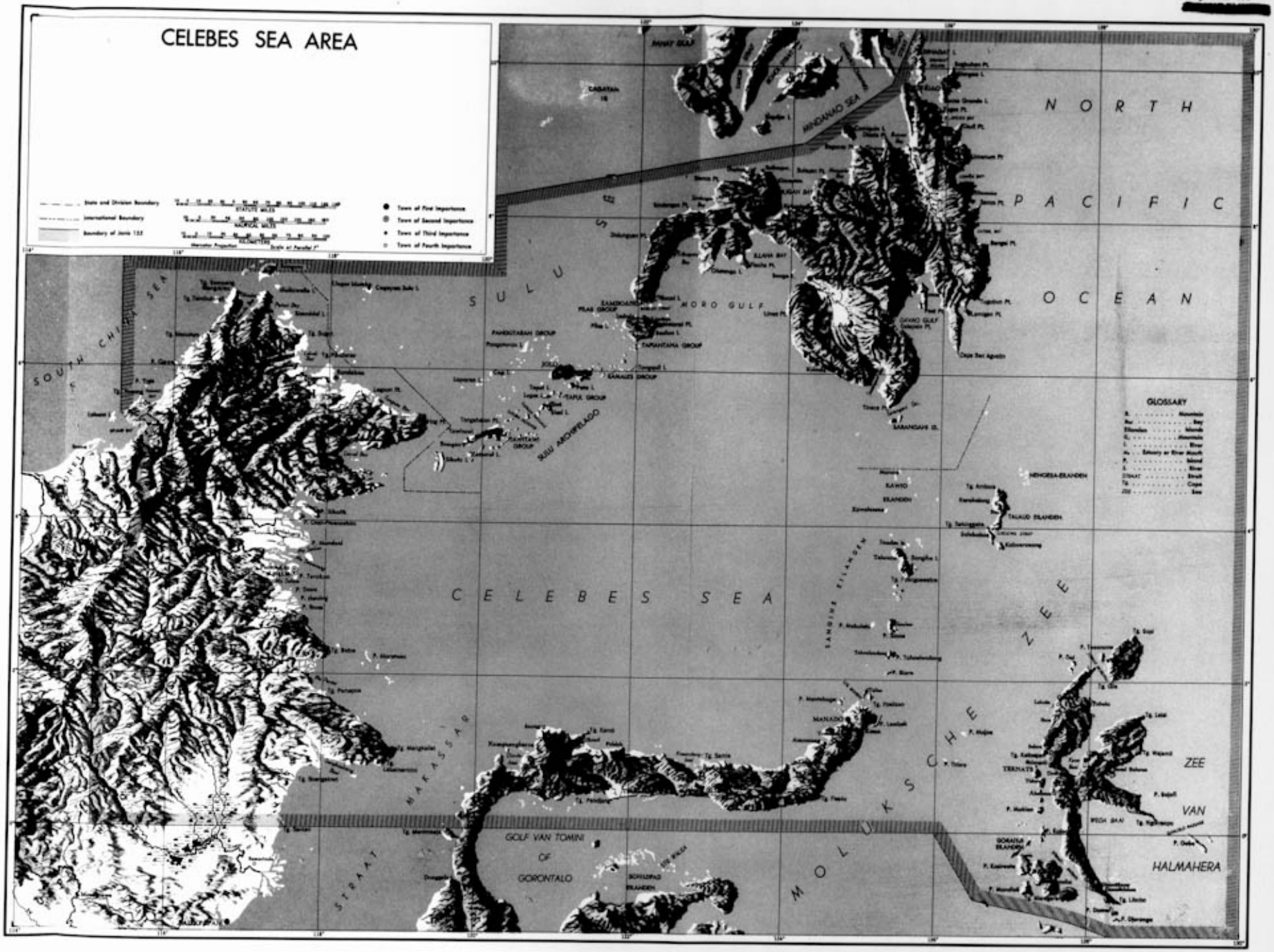
[redacted]



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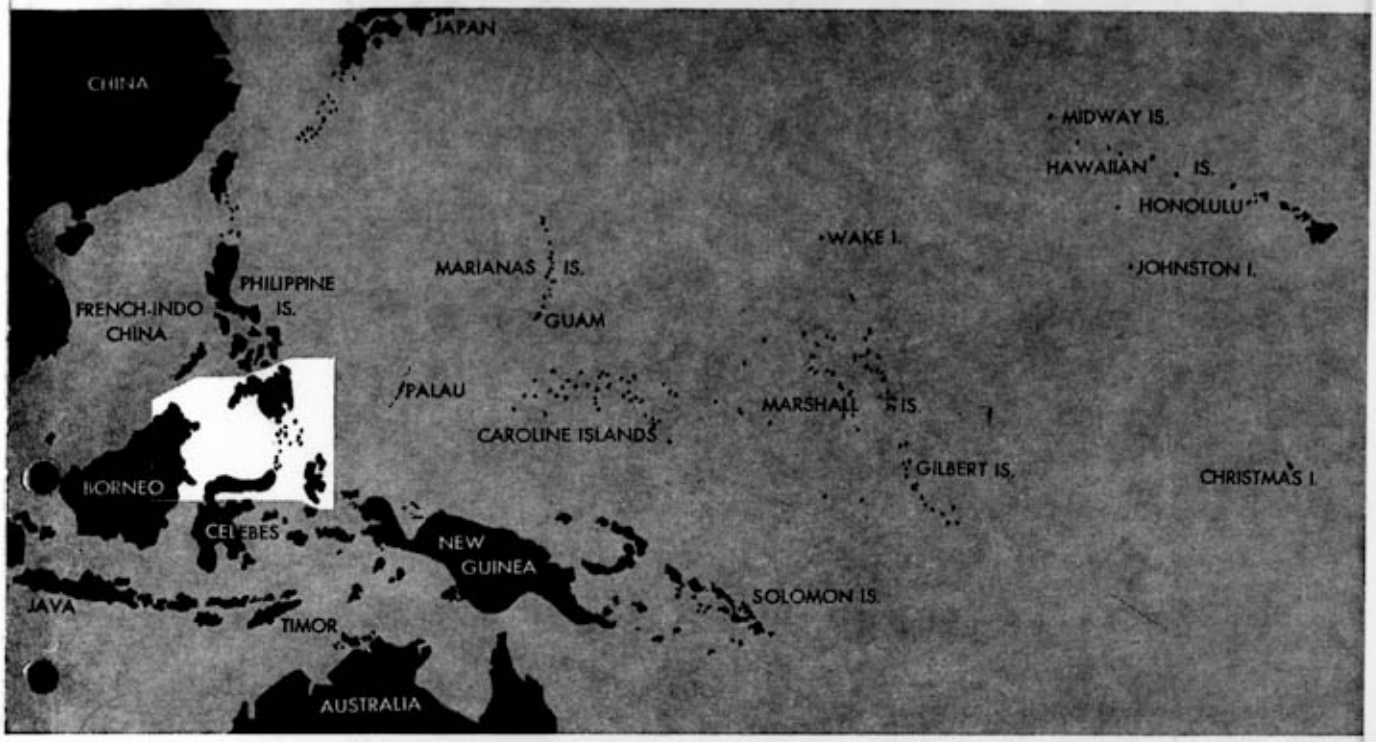
CHAPTER IV

Confidential
Non-registered



JOINT ARMY-NAVY INTELLIGENCE STUDY

OF

CELEBES SEA AREA

COASTS AND LANDING BEACHES

MAY 1944

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Figure (insert, reverse blank)	Original	Figure IV-227
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Figures (insert, reverse blank)	Original	Figures IV-239 to IV-243
Text and Figures	Original	pp. IV-187 to IV-236
Figure (insert, reverse blank)	Original	Figure IV-293
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Note: This chapter is based on material available in Washington, D.C., on 25 April 1944.

*In general, each coastal region, heads 41 A, 41 B, 42 A, etcetera is subdivided into a coastal description, headings (1) to (4), and a landing-beach description, heading (5), as shown under 41 A.

COASTS AND LANDING BEACHES

40. General Description

Because of the tremendous length and complexity of the coasts on the islands of the Celebes Sea Area (FIGURE IV - 293), a complete coastal description would be far too long for JANIS publication. Many parts of these coasts, however, are of little strategic importance because of offshore dangers, steep cliffs, swampy shores, or remoteness from major towns, air facilities, and centers of military resistance.

In preparing Chapter IV, areas of strategic importance on each main island, island group, or sector, were selected, descriptions of the immediate and adjacent coasts were prepared, and landing beaches that would give access to each area were plotted on maps and charts (PLANS 5 to 61) and were described.

For each coastal area of strategic importance the chapter presents, under headings (*1*) to (*4*), a general coastal description, designed primarily for the use of a ship master or naval commander rather than for a landing party. This description also served as necessary background for the descriptions of landing beaches, heading (*5*), which follow. The outline of description of each coastal area is,

(1) Offshore zone.

Deals largely with area seaward of 5-fathom line.

(2) Coastal topography.

Description of general features of coast, particularly landmarks, cliffs, swamps, estuaries, and shore conditions. Beaches are mentioned merely as landmarks or to note their presence in areas not covered by detailed landing beach studies.

(3) Anchorages.

Deals largely with area seaward of 5-fathom line. For anchorages at major and minor ports, see also descriptions under Port Facilities, Chapter VI.

(4) Dangers to navigation.

Deals largely with area seaward of 5-fathom line.

(5) Landing beaches.

Detail supplementary to general coastal description of headings (*1*) to (*4*).

(*a*) *Single beach or group of closely related beaches.*

1. Location and extent. Includes size of beach and location with regard to landmarks and developed areas.

2. Nearshore. Deals largely with area shoreward of 5-fathom line, bottom gradient, nearshore dangers, local conditions of wind, wave, and tide.

3. Character of beach. General description of beach itself and its suitability for landings.

4. Adjacent terrain and exits. Topography inland and on flanks of beach, communication routes, facilities.

(*b*), (*c*), *etc. Same as* (*a*) *for other beaches of same coastal segment.*

The reliability of each beach description is stated in the heading relative to the following scale:

EXCELLENT—Aerial coverage available; good literature of recent date; good maps; no factual conflicts; little or no interpretation needed.

GOOD—Aerial coverage optional; good literature of recent date; good maps; no factual conflicts; some interpretation involved.

FAIR—No aerial coverage; fair to good literature often not of recent date; fair to good maps; considerable interpretation required.

POOR—No aerial coverage; literature poor or old; maps indifferent; much interpretation required.

In Chapter IV, distances stated in coastal description, headings (*1*) to (*4*), whether over water or over land, are nautical miles. In beach descriptions, heading (*5*), all distances are statute miles.

Standardization of place names in the Celebes Sea area presents peculiar problems. In Chapter IV, variants of the spelling of proper names are shown in parenthesis, where there is any marked difference. Descriptive names and feature names are given in English throughout. English equivalents of common descriptive names and abbreviations are as follows.

Ake (A.)	river	Kuala (K.)	river
Baai (Bi.)	bay	Lae, Le, Live, Low (L.)	river
Batoe (Bt.)	islet, rock	Muara, Moeara (Ma.)	estuary or river mouth
Besar (Br.)	large, great	Pasir, Pasi	shoal, reef, bank
Boeloe (B.)	mountain	Pulau, Poelau (P.)	island
Bukit, Boekit (Bt.)	hill	Riffen	reefs
Eil, Eiland, Eylandt	island	Soengai, Sungei (S., Si.)	river
Eilanden (Eiln.)	islands	Straat (Str.)	strait
Gebergte (Geb.)	mountains	Tandjoeng, Tanjong (Tg.)	cape, point
Groot (Gt.)	great	Telok, Teloek (Tk.)	bay, cove, creek
Gunong, Goenoeng (G., Gn.)	mountain	Zee	sea
Kali (K.)	river		
Kampoeng (Kg.)	village		
Karang (Kg.)	rock, reef, coral		
Ketjil (Ktl.)	little		

The coastal regions and landing areas of each of the 6 sectors described in Chapter IV are summarized below.

Halmahera (Topic 41). Areas described are on the west and east coasts of the northern peninsula, on the east coast of Kaoe Bay, and on off-lying islands, especially Ternate and Morotai.

Sangihe and Talaud Islands (Topic 42). Important coastal features and leading beaches of all the major islands are discussed.

Mindanao (Topic 43). Four coastal segments are described: The Surigao area, in the northern part of the northeastern peninsula of Mindanao. The Cagayan and Misamis areas, including Macajalar and Iligan Bays, of the north-central coast. The Zamboanga Peninsula, the western end of Mindanao. The Davao Gulf area in southeastern Mindanao, including bays just east and west of Davao Gulf as well as the Gulf itself.

Basilan Island and the Sulu Archipelago (Topic 44). Areas described are on Basilan and Jolo Islands and on small islands lying close to them. No descriptions are given for the other islands of the Sulu Archipelago, some of which may be of sufficient strategic importance to require further study.

Northeast Borneo (Topic 45). Six areas of special importance are described, Jesselton, on the northwest coast, Marudu Bay, at the north, and the Sandakan Harbor, Darvel Bay, Sibuko Bay, and Tarakan Island areas on the northeastern and eastern coasts.

Northern Celebes (Topic 46). The coasts and landing beaches of sections lying near ports or giving access to strategic cross-peninsula routes are emphasized.

For each sector, generalized descriptions of segments of coast not described in the text will be found on the PLANS.

41. Halmahera

A. Djailolo Bay and vicinity.

(PLANS 3 to 5, 7 to 10 and FIGURES IV - 1 to IV - 4, and IV - 293)

(1) Offshore zone.

(*a*) *Sahoe Bay.* (PLAN 7) The best landmark for this area is conspicuous Salo Island, which lies close to the coast about 1½ miles northward of Kaetkaet Point. The approach to Sahoe Bay is over a steep sand bottom, and is clear to the 18-foot curve which lies about 1,000 feet off the beach. Heavy swells run in the bay with the slightest westerly wind and a heavy surf is experienced from December to April.

(*b*) *Djailolo Bay.* (PLANS 7 to 10) Djailolo Bay is about 3¼ miles wide at the entrance and recedes about 4 miles. Its depths range from 22 to about 75 fathoms. In Djailolo Road the 10-fathom curve is about 500 yards beyond the edge of the fringing reef. The depth 1,000 yards from the shore averages about 25 fathoms. The bottom is mud, sand, or coral. During the strong westerly winds which occur frequently during the north monsoon, swells and surf are experienced in the bay.

The approach to the village of Djailolo is through a narrow channel in the fringing reefs, apparently navigable only by vessels of shallow draft.

The approach to the village of Takaleka in the bight south of Djailolo Bay is over a gradually sloping coral sand bottom. The bight is open to the westerly winds and seas of the north monsoon.

(2) Coastal topography.

(*a*) *Sahoe Bay.* The land behind and also northward of Soesoepoe consists of a narrow plain which rises inland along the steep, wooded slopes of Honor Mountain. Southward from here there is a broad plain which extends inland for about 5 miles and thence southward around a mountain peak, 3,705 feet high, to the head of Djailolo Bay. Small boats can enter the Lamo River at low water. The Diri River, which empties into Sahoe Bay about ¾ mile southward, is not navigable.

(*b*) *Djailolo Bay.* The village of Djailolo lies on the northern side of Djailolo Bay, but cannot be seen from offshore as it is hidden by mangroves. The bay, exposed to the west winds, lies between Kailoepa Point and Goeai Point (FIGURE IV - 1). The small coral islet, Baboea, 59 feet high and surrounded by a reef, lies ½ mile northwest of Goeai Point.

A drying reef extends more than 300 yards from the low shores of the bay. Extensive mangrove swamps are intersected by small sandy beaches. Djailolo Bay provides few good landing sites. The best is at the Djailolo wharf.

A cart road runs westward to the village of Bobopajo near the coast of Cape Kailoepa. A coastal path runs southward to Sidangoli.

Tofiri Island, in the entrance to Tofiri Bay and 3 miles south of Goeai Point, is small and surrounded by a reef. Of the several villages located on the shores of this bay, Takaleka is the largest.

Sidangoli Point, situated about 7 miles south of Goeai Point, is the northern limit of Dodinga Bay. Southward and eastward of the point are a number of low mangrove-covered islands and reefs, which front the coast. On a small inlet near the point is a village to which vessels from Ternate are brought for repairs. The village of Sidangoli is located a short distance inland.

FIGURE IV - 1. *Halmahera Island, Djailolo Bay.*
From E shore of bay, looking W toward Kailoepa Point.

(3) Anchorages. (See Chapter VI.)

(4) Dangers to navigation.

There are several shoals off the drying coastal reef in Djailolo Bay. Also about ¾ mile north-northeast of the islet Tofiri, which lies 3 miles south of Goeai Point, is a drying reef, and ¼ mile farther to the northward is a 3-fathom shoal. The head of Tofiri Bay is obstructed by numerous charted detached reefs and shoals which lie close seaward of the 5-fathom curve. Pasir Lamo, a 2¼-fathom shoal lies 2 miles west of Point Sidangoli.

(5) Landing beaches. (PLANS 5 to 10)

(*a*) *Sahoe Bay beach.* (PLAN 7, Section A(a)) Reliability FAIR. A sandy beach interrupted by 2 river mouths lies on the west coast of Halmahera Island at the head of Sahoe Bay, extending south from the village Soesoepoe at 1° 09′ N, 127° 26′ E, for a distance of about 3¼ miles. It is possible that the beach continues northward from Soesoepoe as far as Taroeba Point, a distance of about 1½ miles. Shoreward of the 18-foot curve the approach to the beach is clear, but caution should be exercised to avoid shifting sand bars which lie near the center of the area between the mouths of the rivers Lamo and Diri.

The steep firm beach is composed of sand. The best place to land is on the section of the beach which lies between the mouth of the Lamo River and Soesoepoe village. Exit from the beach lies along the coastal trail which runs from Gorogoro village 8½ miles north of Soesoepoe village to Djailolo village, about 12 miles by trail to the southwest. Soesoepoe village and Djailolo village are connected by an automobile road which traverses the plain and serves a reported air strip located near the village Ngaon between the rivers Lamo and Diri. The Lamo River is crossed by a one-lane, steel bridge and the Diri River by a wooden bridge.

(*b*) *Djailolo Bay: north shore.* (PLANS 7 and 8, Section A(b); FIGURES IV - 1 to IV - 2) Reliability FAIR. Sandy beaches exist in front of the villages of Djailolo and Kampoengdjawa on the north shore of Djailolo Bay. It is possible, however, that numerous small beaches lie in breaks in the mangrove westward from Djailolo village, 1° 04′ N, 127° 28′ E, to Kaetkaet Point, 1° 03′ N, 127° 24′ E. Landmarks for the area include a twin-peaked mountain (FIGURE IV - 2) which lies about 2½ miles west of the village; 3 small hills which lie on Goeai Point, the southern entrance point to Djailolo Bay; and the small coral islet, 59 feet high, surrounded by a reef which lies about ½ mile northwest of Goeai Point.

The approach to the north shore of Djailolo Bay is clear to the seaward edge of the fringing coral reef except at a point about 1 mile southwest of Djailolo village where there is a

FIGURE IV - 2. *Halmahera Island, Djailolo Bay.*
Beach on NE shore of bay between Toada and Balisa, looking NW across Djailolo Bay toward Djailolo Mountain. 1933.

shoal, least depth 12 feet. Shoreward in this immediate vicinity the 30-foot depth lies about 1,000 feet off the shore. Here and off the pier at Djailolo the fringing reef is narrow, but over the remainder of the area it is in general extensive (PLAN 8). During the strong westerly winds which occur frequently during the north monsoon, swells and surf are experienced in the area.

The beaches in this area are composed of coral sand but have outcrops of rock on them. They are narrow, steep, and soft under foot as they have a marshy base. A pier, about 600 feet long, lies across the beach to deep water in front of Djailolo village. The landward 540 feet of the pier is of stone; the outer portion is wood. At the eastern end of the village, in the mouth of a small stream, 2 small piers lie in breaks in the mangrove.

West of Djailolo the land behind the beach consists of a low plain which rises inland along the steep slopes of Djailolo Mountain. East of the village there is an extensive, fertile, well-populated plain which swings in an arc westward around Djailolo Mountain to the shores of Sahoe Bay. Exit from the beaches lies along a cart track which runs west from Djailolo to the village Bobopajo. Northward from this point a trail leads to Soesoepoe. Soesoepoe may also be reached from Djailolo by an automobile road which traverses the plain. The road serves the villages on the plain and runs close to 2 reported air strips. The 2 rivers are spanned by bridges; the largest a one-lane, steel bridge.

(*c*) *Djailolo Bay: head.* (PLAN 7, Section A(c); FIGURE IV - 2) Reliability FAIR. A sandy beach, about 1½ miles long, lies at the head of Djailolo Bay, extending northwestward from the village Toada, 1° 03′ N, 127° 30′ E. Landmarks for the area include the 3 small hills which lie on Goeai Point about 3½ miles southwest of Toada, and the small coral islet, Baboea, 59 feet in height, which lies about ½ mile northwest of Goeai Point. The approach to this stretch of coast is obstructed by a 2½-foot shoal which lies off the reef in front of Toada village and a few rocks and detached reefs which lie near the northwestern end of the area. Off Toada village the fringing coral reef is extensive, but northwestward it narrows and finally disappears into the sandy shore at Balisa village. During strong westerly winds, waves break heavily on the beach.

The beach is composed of coral sand (FIGURE IV - 2). It is narrow, moderately steep, and firm except at the northwestern end of the area where it is soft under foot. The Djadoem River cuts across the beach near the center of the area.

The land behind the beach in the vicinity of Toada consists of a narrow plain which rises inland along steep slopes to the hills of the interior. About ½ mile northwest of Toada village the hills trend away from the coast, and the beach is backed by the extensive Djailolo plain. Exit from the beach in the vicinity of Toada lies along the trail which runs along the foot of the hills south to Baroe village. Northwest of Toada the trail follows the hills as far as the village Todowongi, where it loops inland across Djailolo plain to Djailolo.

(*d*) *Takaleka.* (PLANS 9 and 10, Section A (d)) Reliability FAIR. A possible landing beach lies on the west coast of Halmahera Island in the bight south of Djailolo Bay in front of the village Takaleka, 0° 57′ N, 127° 31′ E. The best landmark for the area is small Tofiri Island, surrounded by a reef, in the entrance to a bight about 3 miles south of Goeai Point. The approach to this landing area over a gradually sloping coral sand bottom is obstructed by numerous charted, detached reefs and shoals which lie close seaward of the 30-foot depth. Off the village, the 30-foot depth lies about 1,200 feet from the shore, which is lined with a fringing coral reef about 500 feet wide.

This area is open to the westerly winds and seas of the north monsoon.

The coral-sand beach is narrow, steep, and firm. It is cut by a stream which lies immediately south of the village.

The land behind the beach consists of a narrow plain which rises along moderate to steep slopes to the mountainous interior. Exit from the beach lies along a trail which runs southward from the village Takaleka to the village of Sidangoli. From Sidangoli village a trail crosses Halmahera Island to the mouth of the Lame River, which empties into Kaoe Bay.

(*e*) *Sidangoli.* (PLANS 9 and 10, Section A(e); FIGURES IV - 3 and IV - 4) Reliability GOOD. A sandy beach, about 3½ miles long, lies on the west coast of Halmahera Island north of the northern entrance point to Dodinga Bay. The village of Sidangoli lies near the southern end of the area a short distance inland from the mouth of the Sidangoli River. The approach to this stretch of coast is obstructed by the 13½-foot shoal, Pasir Lamo, which lies about 2 miles west of Sidangoli. Shoreward there are numerous charted reefs and shoals south of Sidangoli, but north of the village the approach is clear to the fringing coral reef. During the north monsoon, strong westerly

FIGURE IV - 3. *Halmahera Island, W coast.*
Beach in vicinity of Ratemoe Point northwestward of Sidangoli. 1943.

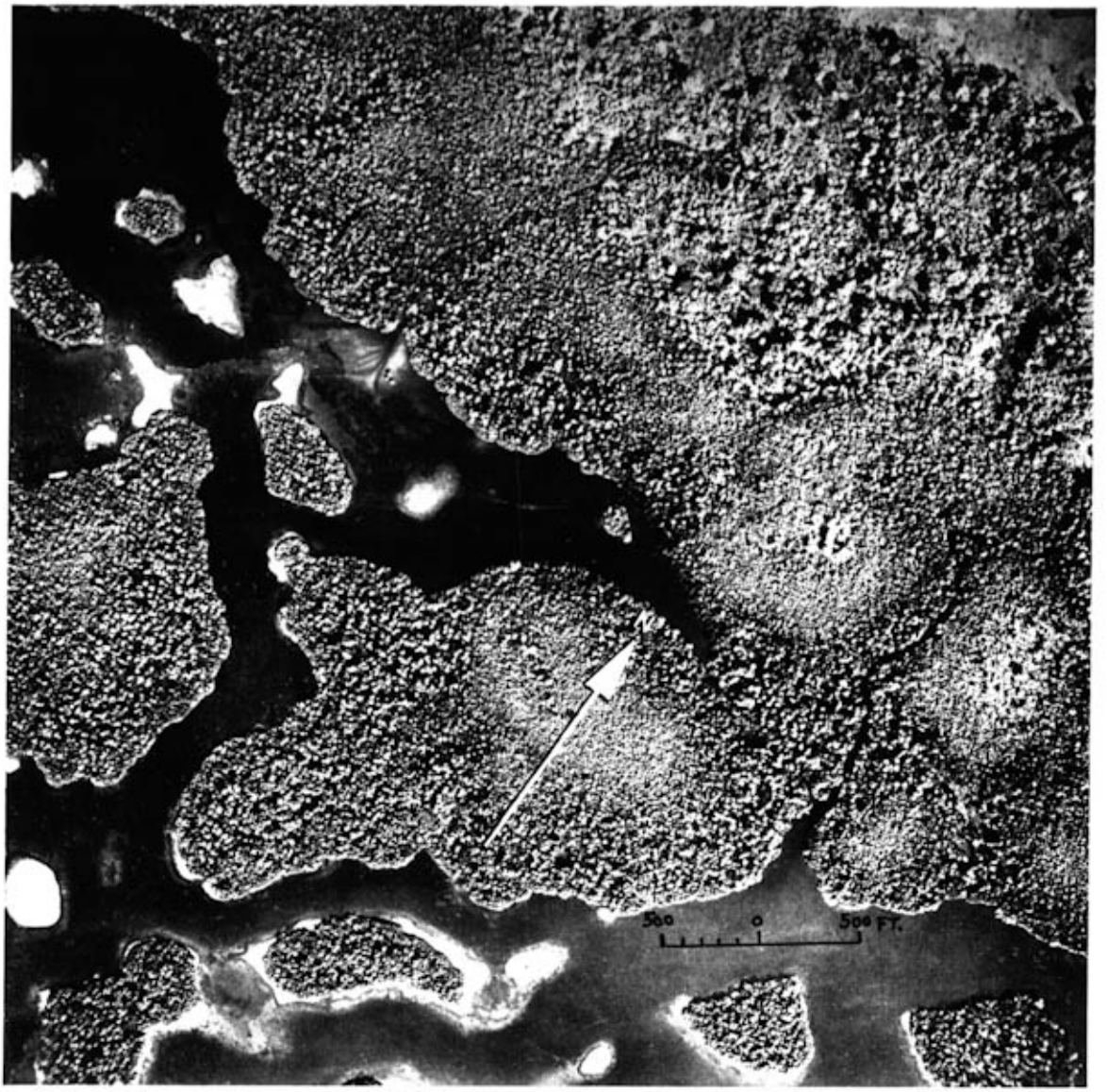

FIGURE IV - 4. *Halmahera Island, W coast.*
Islands E of Manoeamadene Island, on N shore of Dodinga Bay. 1943.

winds create a heavy surf on the beach. The coral sand beach is narrow, steep, and firm, except in a small inlet near Sidangoli village where it has a gentle slope on which boats can be pulled up for repairs. This repair point is used by the fishermen from Ternate Island. The beach near the northern end of the area is shown in FIGURE IV - 3. South of Sidangoli village around the northern entrance point to Dodinga Bay, the shore and offlying islands are covered with mangrove (FIGURE IV - 4).

The land behind the beach is flat and densely wooded. About 1½ miles inland it rises along moderate to steep slopes to the mountainous interior. A trail, covered at high water, lies along the beach. Exit from the beach may be had across the plain to the trail at the foot of the hills which runs from Sidangoli northward to Takaleka village. Two trails run eastward from Sidangoli to Kaoe Bay on the east coast of the island.

B. Dodinga Bay and vicinity.
(PLANS 3 to 5, 9 and 19)

(1) Offshore zone.

The depths in Dodinga Bay decrease gradually, the 100-fathom curve being about 12 miles from the head of the bay and the 10-fathom curve being close to the shore. In the center of the bay the depths are about 40 fathoms. The bottom in the outer part of the bay is composed of coral and sand; near shore, it is of mud. South of Dodinga Bay, as far as Dobegasi

Point, the coast is free from dangers and can be approached to within ½ mile. The 100-fathom curve lies an average of 2½ miles from the coast and the water shoals gradually toward the shore.

(2) Coastal topography.

Dodinga Bay, lying between Sidangoli Point and Oba, is separated from Kaoe Bay, on the east coast, by a narrow isthmus on which the village of Dodinga is located. The coast of the bay has many inlets ½ to ¾ mile long. South of Dodinga Bay, as far as Dobegasi Point, a distance of 10½ miles, the coast is low, but steep and clean. At Oba there is marshland between the shore and the hills. Dobegasi Point is low and fringed by a narrow coast reef.

(3) Anchorages.

There is good anchorage in the inlet at Dodinga village. It is easily approached by steering 78° for the 2 hills close south of the village.

There is no anchorage at Oba. The nearest anchorages are at Ternate and Dodinga. (For details of anchorage at Ternate, see Chapter VI.)

(4) Dangers to navigation.

The islands and reefs near the shore in the northwestern part of Dodinga Bay have been mentioned with Sidangoli Point. About 6 miles eastward of this point are some detached reefs, which lie as much as 1½ miles offshore. About 3¾ miles southeast of the same point lies a 10-foot patch.

In the southern part of Dodinga Bay, and 2¾ miles north of Oba Point, is a reef marked by a beacon and conical topmark. Two shoals, of 3¾ and 5 fathoms, lie 700 yards northeast and southeast, respectively, of the beacon. Two others of 4½ and 5½ fathoms lie 1 mile northwest of this beacon, and a group of reefs lies about 1 mile east-northeast of it. In the channel between the latter reefs and the shore off Goeroeaping there are shoals.

Pasir Radja, located 3½ miles northwest of Dobegasi Point, consists of 2 atolls, on which sand and broken coral have accumulated. At high water springs they are entirely submerged, but may be located by the discoloration of the water; at mean high water a few points of the northern atoll extend above the surface.

(5) Landing beaches.

(*a*) *Dodinga.* (PLANS 5 and 9, Section A(*f*)) Reliability FAIR. A small landing beach lies at the head of Dodinga Bay in a small cove in front of Dodinga village, 0° 51′ N, 127° 38′ E. Although the approaches to this small pocket beach are obstructed by a number of charted reefs and shoals, there is clear approach through the center of the bay. The beach area is well sheltered from westerly winds and seas by the islands of the Ternate group.

The beach is composed of sand brought down by the Likata River, with coral sand occurring locally. The beach is wide, with a moderate to steep slope near the high water line. The slope of the seaward portion, that washed by the tides, is gentle to moderate. In general the beach is firm, but near the river mouth it may be soft.

The beach lies on the western side of the isthmus, 2 miles wide, that separates Dodinga Bay on the west coast of Halmahera Island from Kaoe Bay on the east coast. The isthmus is covered with low hills, which rise along moderate slopes from the shore. The Likata River, however, flows through a break in these hills. A road follows up this river valley across the hills on the east coast of the isthmus to Bobaneigoe village, a landing place in Bobane Bay at the head of Kaoe Bay. A trail also runs south from the beach to the village of Tewe and north around the shore of Dodinga Bay to Sidangoli village.

(*b*) *Galala—Sofifi.* (PLANS 5 and 9, Section A(g)) Reliability FAIR. A sandy beach about 2 miles long lies on the south shore of Dodinga Bay between the villages Sofifi, 0° 44′ N, 127° 33′ E, and Galala, 0° 45′ N, 127° 35′ E. It is possible, however, that the beach continues as far northeast as Tewe village and as far south as Loleo (Goerabati) village. The approach to the stretch of coast north of the beach area is obstructed by the shoals lying off the southern shore of Dodinga Bay. Off the beach and to the southward, the coast is low but steep and clean, except for the reefs Pasir Radja, which lie about 2 miles northwest of Dobegasi Point.

The narrow, steep, firm, coral-sand beach is fronted in places by a fringing coral reef and widely scattered, small detached reefs. At the village of Sofifi a small landing jetty lies across the beach. Numerous large streams cut the beach along this stretch of coast. (FIGURE XII - 19)

In general the land behind the beach consists of a coastal plain of varying width which rises along moderate to steep slopes to the mountainous interior. At a few points, however, the hills rise steeply from the shore. On the moderately wide plain behind Sofifi village there is an air strip 3,400 feet long. Trails in this area follow the coast along the plain but along the steep areas communications are maintained by canoe. At the northern end of the area a trail runs northeastward from the village Tonikoe-islam to the head of Kaoe Bay on the east coast of Halmahera Island.

C. Hiri and Ternate Islands.

(PLANS 3 to 6, 10, and 11; FIGURES IV - 5 to IV - 12)

(1) Offshore zone.

The 100-fathom curve lies about ½ mile off the coast of Hiri Island, and the depths toward shore decrease abruptly. Ternate Island is separated from Hiri Island, lying to the northward, by a clear channel nearly 1 mile wide.

Ternate Road is the open roadstead off the southeastern side of Ternate Island (FIGURES IV - 5 to IV - 7). Gamme Lamo Channel, the southwestern approach to Ternate Road, lying between Ternate and Tidore, has a least depth of 19 fathoms in the fairway (FIGURE IV - 8).

In Ternate Road the shore is bordered by a coastal reef of coral which narrows from 400 yards width in the north to about 25 yards in the south, and there disappears altogether. The 3-fathom curve lies at a distance of about 100 yards and the 10-fathom curve about 200 yards beyond the edge of the fringing reef. Outside the 10-fathom curve the water deepens gradually, a depth of 40 fathoms being found ½ mile offshore.

At Ternate there is both a diurnal and a semidiurnal tide, but the latter predominates. Spring highs and spring lows of the 2 tides may coincide. The highest water level under such conditions occurs in June and December. The maximum rise and fall that can be expected are, respectively, about 2.3 feet above and 1.6 feet below mean sea level.

A strong current sets through the road at times. High water

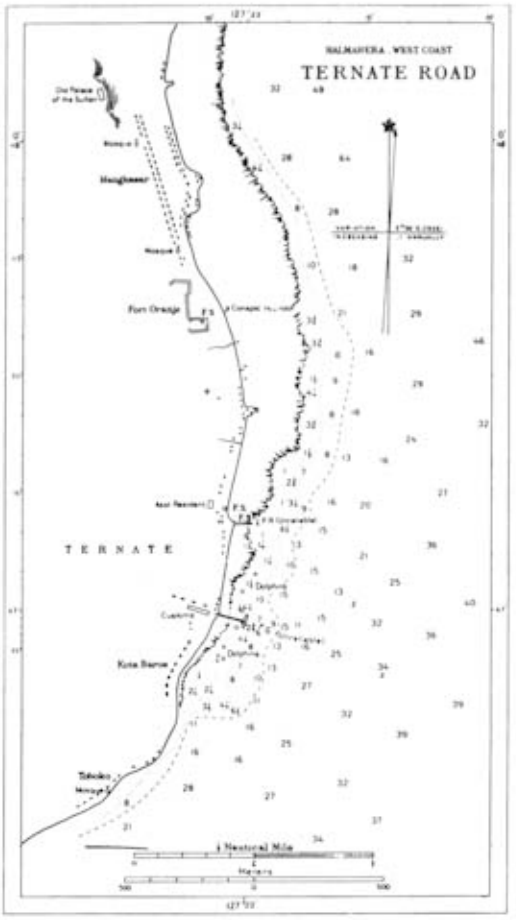

FIGURE IV - 5. *Ternate Island, E coast.*
Hydrographic chart of Ternate Road.

is accompanied by a current setting to the northward and low water by a current setting to the southward.

(2) Coastal topography.

Hiri Island is about 1¾ miles in diameter and rises to a conical peak 2,065 feet high (FIGURE IV - 9). The coast is cliffy along the northeastern side and on the west at Point Kao-Tjina. There is a fringing reef at the latter point and also along the north, east, and south sides from Saka to Tafraka Point.

Ternate Island is about 7 miles in diameter and is almost entirely composed of a conical active volcano, Mount Ternate, 5,625 feet high. The eastern slope of the volcano is the most undulating and gradual; the northern and northwestern sides drop more sharply to the water level (FIGURE IV - 10). In the wide collapsed crater, which is wooded, a new and barren cone has risen. Two clefts on the northwestern side continue as ravines all the way down to the shore. On the north-northeast side there is a bare black rib of lava extending from the crater to the sea, where it ends in a broad, high, perpendicular cliff called Batoe Angoes Point. There are 2 small crater lakes at the northwestern end of the island and 1 at the southern end. The latter, about ¼ miles from the town of Ternate, is separated from the sea by a ridge only 30 feet high.

Ternate Island is densely wooded, except in the south and southeast where there are coconut plantations and extensive fruit orchards. Many villages dot the coastal regions. The town of Ternate stretches along the eastern coast from the village of Toboko northward to the village of Mengkasar.

The coast around the island is steep-to in places, with alternating shelving sandy or gravel beaches. There are narrow coastal reefs but almost none that dry. The shelf is narrow; it attains noticeable width only on the southeastern side, where it joins the Tidore shore. The longest stretch of beach and coastal plain is the narrow strip extending on the eastern shore from Toboleoe southward through Ternate to Toboko. The coastal plain is shorter on the south and is steepest on the west side of the island. Landings at high tide by shallow-draft landing craft should be possible in the lee of the island in all seasons.

FIGURE IV - 6. *Ternate Island, E coast.*
Looking S past pier at Ternate and across Gamme Lamo channel to Tidore Mountain on Tidore Island.

FIGURE IV - 7. *Ternate Island, E coast.*
Offshore at Ternate, looking SE toward Tidore Island. 1935.

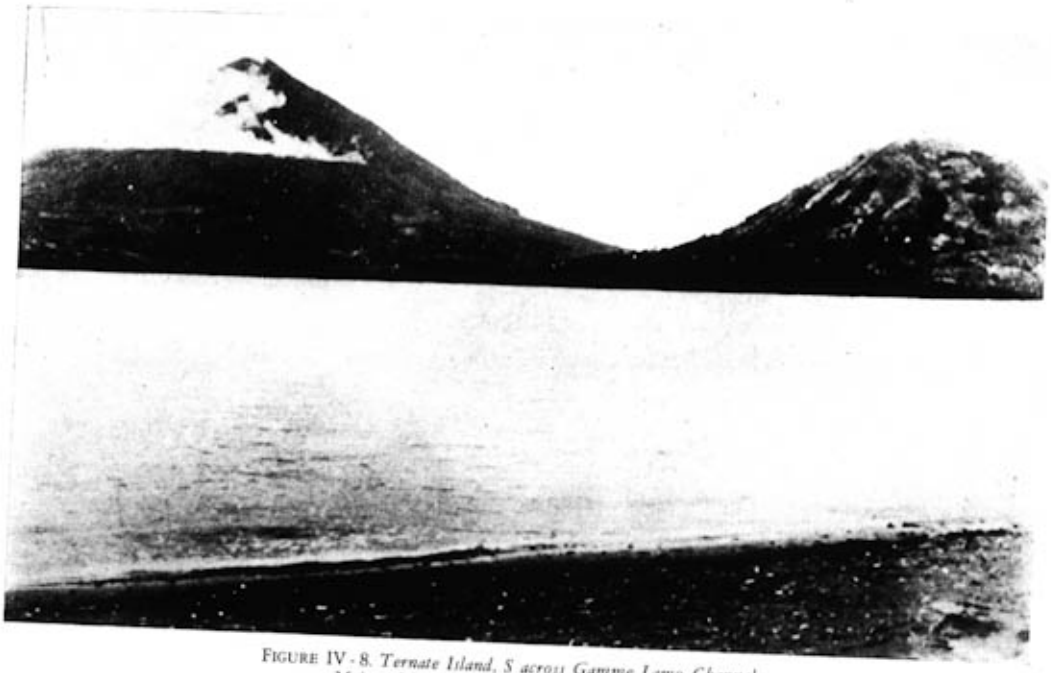

FIGURE IV - 8. *Ternate Island, S across Gamme Lamo Channel.*
Maitara Island is at right, Tidore Island at left.

(3) Anchorages. (See Chapter VI.)

(4) Dangers to navigation.

There are no dangers beyond a few reefs extending ½ mile to 1 mile offshore. At the north point of Ternate Island in the passage between Ternate and Hiri there is a coastal bank which extends some distance offshore, but discolors well.

(5) Landing beaches.

(a) Hiri Island, northeast coast beach. (PLAN 10, Section B(a)) Reliability FAIR. A small beach is situated on the northeast coast of Hiri Island just south of Ngofa'Oedoe Point, 0° 55′ N, 127° 19′ E, the northernmost point of the island. The approach to the shore in this area is clear over a moderately sloping sand bottom to the seaward edge of the narrow, fringing coral reef. The beach, which is composed of a mixture of coral and volcanic sand, is reported to be the best landing place on the island. High seas and heavy surf are encountered during the north monsoon. The beach is backed by steep, forested

FIGURE IV - 9. *Ternate Island, NE coast.*
Looking N toward "Burnt Corner" and Hiri volcano. 1937.

FIGURE IV - 10. *Ternate Island.*
Off W shore, looking E.

slopes which rise to the central peak. Exit is possible along a trail which encircles the island.

(*b*) *Hiri Island, southeast coast beach.* (PLAN 10, Section B(b)) Reliability POOR. A beach possibly lies along the southeast coast of Hiri Island at about 0° 53′ N, 127° 19′ E, between Togolobe Point and Tafraka Point. The approach to this stretch of coast is clear over a steep bottom to the seaward edge of the narrow, fringing coral reef. The beach is composed of a mixture of coral and volcanic sand. Several villages are situated along the shore in this area. Behind the beach, moderate slopes rise to the steep forested volcanic cone, which reaches an elevation of 2,065 feet. The trail which encircles the island runs close to the shore in this vicinity.

(*c*) *Ternate town beach.* (PLANS 5, 10, and 11, Section C(a); FIGURES IV - 6) Reliability GOOD.

1. Location and extent. A sandy beach interrupted by numerous shore installations lies on the southeastern shore of Ternate Island in front of Ternate town at 0° 47′ N, 127° 23′

E. Landmarks for the town include the Rajah's pier, palace, and mosque at the northern end of the area, and a conspicuous mosque at the southern end of the area (FIGURE IV - 6).

2. Nearshore. The approach to this stretch of coast, over a steep sand bottom, is clear to the seaward edge of the fringing coral reef which is about 1,000 feet wide off the center of the town. Northward and southward the reef narrows to about 200 feet (PLAN 11). For most of the year, the winds blow from the west to northeast sector, but from July to October they blow, usually, from the southwest to south-southwest sector. East winds are very rare. Heavy squalls occur occasionally. From December to April troublesome rollers are experienced occasionally. A choppy sea exists when currents set southward against southerly winds. A strong current is occasionally experienced offshore. High water is accompanied by a current setting northward and low water by a current setting southward.

3. Character of beach. The beach in this area is composed chiefly of volcanic sand with coral sand occurring locally (FIGURE IV - 6). In general, it is steep, firm, and narrow, but at a few points where impermeable structures have been built, the impounded sand has created a fairly wide beach. Numerous structures, including piers, stores, and warehouses, are built out over the beach and water. At the northern end of the area there is a pier about 800 feet long which serves the Rajah's palace. Near the southern end of the area there are 2 piers. The northern of these is available only to boats, but the southern one has a "T" head with 13 feet of water alongside. Drinking water is obtained from a well close to a shed near the "T"-head pier.

4. Adjacent terrain and exits. The land behind the beach consists of a coastal plain about 1 mile wide which rises inland along moderate to steep slopes to the crest of Mount Ternate. The seaward edge of the plain is highly developed, with roads, buildings, and scattered clumps of vegetation. Inland, the plain is planted with coconut and fruit trees. Exit from the beach may be had along the streets of the town, which connect to a road that runs along the east coast of the island. This road in turn connects to a cart track which completes the circuit of the island. (FIGURES XII - 10 and XII - 11)

(*d*) *Kajoe Merah Point beach.* (PLANS 5 and 10, Section C(b)) Reliability FAIR. A possible sandy beach lies on the southeast corner of Ternate Island, surrounding Kajoe Merah Point, 0° 46′ N, 127° 22′ E. The approach to this stretch of coast lies through Gamme Lamo channel and is clear to the seaward edge of the fringing coral reef. FIGURE IV - 11 shows the southeastern end of the island with Tidore Island in the background. Offshore the bottom material is largely sand.

The beach is composed of a mixture of volcanic and coral sand with the former predominating. It is narrow, firm, and steep. Two streams cross the beach and divide it into 3 almost equal parts. The land behind the beach consists of a well-cultivated plain, which rises along moderate to steep slopes to the peak of Mount Ternate. The road which runs to the town of Ternate lies at the northern end of the area. Here it joins the cart track which follows the coast westward behind the beach and thence around the island.

(*e*) *Fitoe—Mongi beach.* (PLANS 5 and 10, Section C(c)) Reliability FAIR. A possible sandy beach separated from the Kajoe Merah Point beach by a stretch of cliff is situated on the southwest side of Ternate Island, between the villages, Fitoe and Mongi. The center of the area lies at 0° 45′ N, 127° 20′ E. The approach to this stretch of coast over a coral sand bottom is, in general, clear to the 30-foot depth, which lies about 800 feet offshore. At a point about 2,000 feet southwest of Fitoe village and close seaward of the 30-foot depth, there is a shoal, least depth about 12 feet. The coral and volcanic sand beach is narrow, steep, and firm. It is lined by a narrow, fringing

FIGURE IV - 11. *Ternate Island, SE coast.*
Looking SE from Ternate Island across Gamme Lamo channel toward Tidore Island. 1928-29.

coral reef and backed by a plain planted in coconut and fruit trees, which rise along moderate to steep slopes to the peak of Mount Ternate. A cart track, together with the road which completely encircles the island, lies immediately behind the beach.

(*f*) *Afe beach.* (PLANS 5 and 10, Section C(d)) Reliability FAIR. A small possible landing beach lies on the west coast of Ternate Island in front of Afe village, 0° 48′ N, 127° 17′ E. The approach to this stretch of coast over a steep sand bottom is clear to the 30-foot depth, which lies about 500 to 1,000 feet offshore. Shoreward the beach is lined with a narrow, fringing coral reef. During strong westerly winds a heavy surf breaks on the beach, which is composed of volcanic and coral sand. It is narrow, firm, and steep. A small stream crosses the beach a short distance north of Afe village. Immediately behind the beach there is a narrow plain which is planted in coconut palms and fruit trees. A short distance inland the plain rises along moderate to steep slopes to the peak of Mount Ternate. A cart track, which encircles the island and is passable to motor vehicles only in the dry season, lies immediately behind the beach.

(*g*) *Togafo—Banedinga beach.* (PLANS 5 and 10, Section C(e)) Reliability FAIR. A possible landing beach lies on the west coast of Ternate Island in the vicinity of Togafo and Banedinga villages, 0° 49′ N, 127° 17′ E. Approach to this landing area is over a steep sand bottom and is clear to the 30-foot depth, which lies about 500 feet offshore. Shoreward the approach is clear to the fringing coral reef. High surf is occasionally experienced along this stretch of coast during the north monsoon. The volcanic and coral sand beach is steep, narrow and firm. In this area the steep slopes of Mount Ternate descend to the narrow, well-wooded plain which lies immediately behind the beach. A cart track which encircles the island lies along the seaward edge of the plain.

(*h*) *Laboeha beach.* (PLANS 5 and 10, Section C(f)) Reliability FAIR. A small possible landing beach lies on the western shore of Ternate Island in front of the village Laboeha, 0° 50′ N, 127° 18′ E. The approach to the beach, which is lined by a narrow, fringing coral reef, is clear. The 30-foot depth lies about 500 feet from shore. Heavy surf may be expected on the beach for periods of 1 to 4 days during the north monsoon. The narrow, steep, firm beach is composed of a mixture of volcanic and coral sand. Fresh water, considered by the natives to be unsuitable for drinking, may be had from large Tolire Lake, which lies on the coastal plain about ½ mile northeast of the village. The coastal plain, immediately behind the beach, is planted with fruit trees and coconut palms. It rises inland along the moderate to steep slopes of Mount Ternate. Exit from the beach lies along the cart track which in general follows the coast around the island.

(*i*) *Takome beach.* (PLANS 5 and 10, Section C(g)) Reliability FAIR. A possible beach lies on both sides of Takome village along the shallow bight on the west coast of Ternate Island between Doekomadihi Point, 0° 50′ N, 127° 18′ E, and Mari Sarsara Point, 0° 52′ N, 127° 19′ E. The best landmark for the area is the main peak on Hiri Island, which lies about 1¼ miles north of Mari Sarsara Point. The approach to this stretch of coast over a steep sand bottom is clear to the 30-foot depth, which lies 200 to 400 feet offshore. Shoreward, the approach to the narrow, steep, firm, volcanic sand beach is clear. Heavy surf is experienced along this stretch of coast during the north monsoon. Fresh water, which is not suitable for drinking, may be obtained from little Tolire Lake. The Takome River cuts across the beach near the southern end of the area. The land behind the beach consists of a well-wooded plain about 1 mile wide. Inland it rises along the moderate to steep slopes of Mount Ternate. A cart track which encircles the island lies on the plain behind the beach about ¼ mile from shore at the southern end of the area and about 1 mile from shore at the northern end.

(*j*) *Pasir Poetih Point beach.* (PLANS 5 and 10, Section C(h)) Reliability FAIR. A possible landing beach, about 1½ miles long, lies on the northeast shore of Ternate Island on both sides of Pasir Poetih Point, 0° 52′ N, 127° 20′ E. The best landmark for the area is Hiri Island the shore of which lies about 2 miles northwest of Pasir Poetih Point. The approach to this beach area over a steep coral and sand bottom is clear to the 30-foot depth, which lies about 800 feet offshore east of Pasir Poetih Point, but which west of the point swings about 2,000 feet seaward. Shoreward the approach is clear to the fringing coral reef. During the north monsoon, swells break heavily on the fringing reef. The beach is composed of a mixture of coral and volcanic sand with the latter predominating. Large quantities of volcanic debris may be encountered on the reef and beach. Immediately behind the beach the well-wooded coastal plain rises about 1¼ miles inland along the steep to moderate slopes of Mount Ternate. A cart track which encircles the island lies a short distance behind the beach.

(*k*) *Batoe Angoes Point beach.* (PLANS 5 and 10, Section C (i); FIGURE IV - 12) Reliability FAIR. A small pocket beach lies near the center of the northeast coast of Ternate Island immediately southeast of Batoe Angoes Point, 0° 50′ N, 127° 22′ E. The beach is easily recognized as it lies adjacent to the cliffed, rocky end of an old lava flow. The approach to this landing place is clear to the 30-foot depth, which lies about 1,000 feet offshore. Shoreward the approach is clear to the volcanic sand beach strewn with volcanic debris (FIGURE IV - 12).

At the upper limit of the beach there is a low cliff behind which lies a coastal plain about 1 mile wide that is planted with coconut palms and fruit trees. Inland the plain rises along the moderate to steep slopes of the main mountain peak of the island. A cart track which connects to the Ternate town road lies close behind the beach.

(*l*) *Batoe Angoes Point—Toemboekoe Point beach.* (PLANS 5 and 10, Section C(j)) Reliability FAIR. A possible landing beach, about 2¾ miles long, lies on the northeastern shore of Ternate Island between Batoe Angoes Point, 0° 50′ N, 127° 22′ E, and Toemboekoe Point, 0° 49′ N, 127° 23′ E. The best landmark for this area is the town of Ternate, which lies about 1¼ miles south of the southern end of the area. The approach to this stretch of coast is clear to the seaward edge of the fringing coral reef. Heavy seas and surf are experienced from December to April. Heavy squalls occur occasionally. Currents run northward on the flood and southward on the ebb.

The beach is composed of a mixture of volcanic and coral sand. It is narrow, firm, and steep. At the northern end of the area great quantities of volcanic debris are strewn over the beach and reef flat. A number of streams cross the beach in the southern half of the area. The plain behind the beach is planted with coconut palms and fruit trees. About 1 mile inland it rises along the steep to moderate slopes of Mount Ternate. The greater portion of the area is backed by a cart track. The road northward from the town of Ternate lies a short distance be-

FIGURE IV - 12. *Ternate Island, NE coast.*
Small pocket beach near Batoe Angoes Point, looking NW toward Hiri Island. 1933.

hind the cart track over the southern half of the area but connects to it at the center and southern ends of the beach.

D. Galela Bay.

(PLANS 5, 12, and 15; FIGURES IV - 13 to IV - 17)

(1) Offshore zone.

Galela Bay lies between the low Salimoeli and Loewari Points, which are 10¾ miles apart. The bay recedes 7 miles to the westward. The 100-fathom line lies about 1 mile off the entrance points and about 3 miles offshore at the head of the bay. Galela Road, off Galela village, is in the southwestern corner of the bay. Landmarks are the "zinc" roofs of the village, which can be observed 8 miles out to sea. In Galela Road, the bottom falls off sharply, there being depths of 20 fathoms within 300 yards of the shore. The bottom is hard except in the southwestern part, where it is sand. (FIGURE IV - 13)

Galela Road is sheltered during the southeast monsoon, but is not safe during the northwest monsoon on account of the rollers. Currents in the vicinity are negligible until about 6 or 8 miles off, when the monsoon drifts become noticeable. There is both a diurnal and semidiurnal tide, but the latter predominates. Neither the spring highs nor the spring lows of the 2 tides coincide. The maximum rise and fall that can be expected are about 2 feet above and 2 feet below mean sea level.

(2) Coastal topography.

The northern shore of Galela Bay lies close to the foothills of a mountain range. The surface is flat to undulatory, with an abrupt rise to the bordering mountains. The western shore is backed by a broad plain through which flows the Tiabo River. The area on either side of the lower Tiabo, as far north as Gilitopa, is an almost impenetrable marsh. The Tiabo can be entered by boats under 5-foot draft. On the southern part of the plain are 2 detached hills, Little Tarakani Mountain and Big Tarakani Mountain, 918 and 1,247 feet high, respectively.

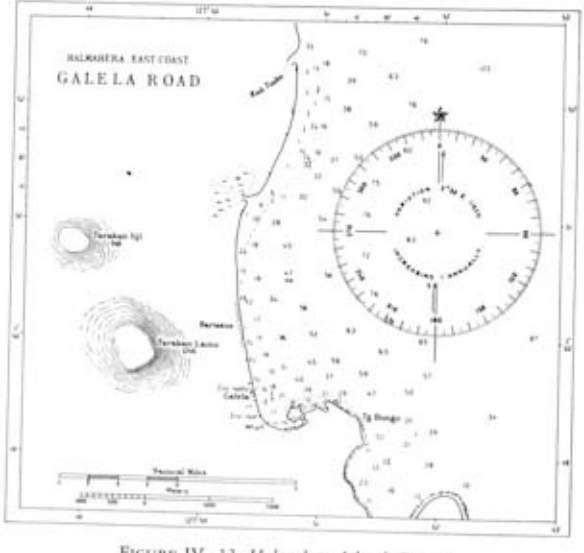

FIGURE IV - 13. *Halmahera Island. E coast.*
Hydrographic chart of Galela Road.

There are low, rolling hills on the southern side of the Galela plain. The southernmost entrance point of Galela Bay is low but may be identified by Mamoeja, the 3,060-foot conical mountain 2 miles south of it. From Galela a trail leads southward and eastward along the coast through the villages of Mamoeja and Loewari. (FIGURES IV - 14 and XII - 12)

FIGURE IV - 14. *Halmahera Island, E coast.*
Coast in vicinity of Galela, looking southwestward. 1939.

(3) ***Anchorages.*** (See Chapter VI.)

(4) Dangers to navigation.

The coast may be approached close to, as it is clear except for two 1-fathom patches close off the northern shore. The Momow Reefs, covered by 3¾ fathoms and 4¼ fathoms, lie about 12 to 14 miles offshore in the approach to the bay.

(5) Landing beaches.

(a) Big Lalonga—Bobisingo beach. (PLANS 5, 12, and 15, Section D(a)) Reliability POOR. A wide sandy beach lies on the east coast of the northern peninsula of Halmahera, along the north shore of Galela Bay between Big Lalonga and Bobisingo villages; it is possible that this beach continues northeastward as far as Aroe Point. The known beach area together with the possible beach lies between 1° 56′ N, 127° 53′ E, and 1° 58′ N, 127° 56′ E. The approach to this stretch of coast is clear over a steep bottom to the seaward edge of the fringing coral reef, which is steep-to, except for a 6-foot shoal about 3,000 feet east-northeast of the village Posiposi. The area is open to the seas and winds of the southeast monsoon, and rollers are experienced during the northwest season. There are no currents close to shore.

The beach is composed of a mixture of coral and volcanic sand. It is wide, moderately steep, and moderately firm. A number of small streams cross the beach in the area. They are almost dry at low water, have bars at their mouths, and are navigable only to small native canoes.

The terrain behind the beach along the southern part of the area consists of a narrow plain which lies at the foot of a mountain range. North of Bobisingo village the hills recede from the coast and the plain becomes extensive. Exit from the beach lies along a trail immediately behind the beach. Some sources indicate that the trail stops to the south at the extensive marsh which lies on either side of the Tiabo River, but others indicate that the trail crosses the marsh and continues to the village of Galela and beyond. At the northern end of the area a trail swings inland along the Aroe River valley joining the trail on the west coast of the island at the village Doitia.

(b) Limaoe beach. (PLANS 5, 12, and 15, Section D(b)) Reliability POOR. A small landing beach lies on the western shore of Galela Bay, in front of the village Limaoe, 1° 55′ N, 127° 51′ E. The approach to this landing place is clear to the seaward edge of the fringing coral reef, which is steep-to. Offshore the steep bottom is composed of rock and sand. During the northwest monsoon heavy rollers exist in the bay and landing is difficult.

The beach is composed of coral and volcanic sand, is wide, moderately steep, and moderately firm. A stream lies at the northern end of the area. The best place to land is in front of the village where there is a break in the reef. The terrain behind the beach is a plain about ½ mile wide, which rises inland along the steep wooded slopes of a mountain range. Southward from the area the hills recede from the coast and the plain becomes extensive and marshy. A trail lies immediately behind the beach.

(c) Galela beach. (PLANS 5, 12, and 15, Section D(c); FIGURES IV - 13 and IV - 15 to IV - 17) Reliability FAIR.

1. Location and extent. A sandy beach about 2 miles long lies on the southern portion of the west coast of Galela Bay, in the area surrounding the village Galela, 1° 49′ N, 127° 51′ E. Landmarks for the area include 2 detached hills, Little Tarakani Mountain and Big Tarakani Mountain, which lie behind the northern portion of the beach; a group of scattered islets, which lie off the southern end of the beach; 2 piers, which lie near the southern end of the village Galela; and the "zinc" roofs of the houses in the village. (FIGURE IV - 13)

2. Nearshore. The approach to this stretch of coast is clear over a hard sand bottom. The area is sheltered from the southeast monsoon, but during the northwest monsoon heavy rollers break violently on the beach. Currents in the vicinity of the beach are negligible.

3. Character of beach. The beach in this area is composed of coral and volcanic sand with the latter predominating (FIGURE IV - 15). It is narrow, steep, moderately firm, and locally has vegetation extending to the water line. An oblique aerial view of the beach is shown in FIGURE IV - 16. At the village of Galela a sand ridge about 10 feet high covered with coconut palms lies immediately behind the beach (FIGURE IV - 17). Near the southern end of the area, just east of the village, 2 small piers cross the beach. The best place to land is on the beach south of the village, where a small islet protects the beach from the rollers which exist during the northwest monsoon. Fresh water can be obtained from the Tiabo River about 3 miles north of Galela.

4. Adjacent terrain and exits. The terrain behind the beach north of Galela consists of an extensive plain which rises inland along steep slopes to 2 detached hills. South of these hills a valley extends inland from Galela to Galela Lake, which is a

FIGURE IV - 15. *Halmahera Island, E coast.*
Typical beach in the vicinity of Galela village, looking N.

FIGURE IV - 16. *Halmahera Island, E coast.*
Beach at Galela village and northward.

good seaplane anchorage. North of the lake in the vicinity of the village Ngidihopitonoe there is an airstrip. South of Galela the land behind the beach rises along gentle, well-wooded slopes to the interior. Exit from the beach lies along an automobile road which trends southeastward along the coast from Galela to Tobelo. However, a large unfordable river must be crossed at Mede, and there are no local means of ferrying motor vehicles. A trail runs northward from Galela village. The west coast of Halmahera is reached from Galela village by road to the lake region and thence by trail over the mountains of the village Poemadada.

(d) Mamoeja beach. (PLANS 5, 12, and 15, Section D(d)) Reliability POOR. A possible landing beach exists on the southern shore of Galela Bay eastward of Tgomadehe Point, 1° 49′ N, 127° 52′ E, near the villages Mamoeja. The approach to this stretch of coast is clear of dangers to the narrow fringing coral reef. Caution should be exercised in landing near the river mouth, as bars are prevalent in this area. During the northwest monsoon there is a heavy surf on the reef. The beach is composed of a mixture of volcanic and coral sand. It is narrow, steep, and moderately firm. The best place to land is east of the Moeje River. The land behind the beach immediately east of the Moeje River consists of a low, marshy plain which rises inland about 1 mile along the steep, wooded slopes of the mountains. Continuing eastward the plain narrows and the steep slopes of a mountain 3,060 feet high descend close to the shore. The automobile road between Galela village and Tobelo village lies immediately behind the beach.

FIGURE IV - 17. *Halmahera Island, E coast.*
Beach and ridge at Galela village, looking NW.

E. Tobelo—Miti.

(PLANS 5, 12, and 15; FIGURES IV - 18 to IV - 22)

(1) Offshore zone.

A clear channel runs between the foul ground that fronts the Halmahera shore and the Tobelo Islands from Tolonoeoe to Kolorai Island. Clear passages are also found between the islands. There is a boat passage through the reef between Koemoekoemoe Island and Point Pilawana, off Tobelo.

Currents may be encountered outside the islands and along the coast south of Miti, but among the islands and between the islands and the shore there is no current of any consequence.

Two miles southward of Tobelo village there is a good channel between the northern side of Paa Island and the coast, but on the southern side there is no passage.

(2) Coastal topography.

A group of conspicuous mountains lies south of Galela Bay. Kariang Mountain (4,380 feet high) is the highest of the group, but several other peaks rise above 4,000 feet. Southward along the coast, at about 1° 33′ N, the land drops to a broad plain, behind which rise fairly conspicuous hills. (PLAN 12).

The coast from Loewari Point to Katana (Gotana) is mostly

low, with numerous small rivers. Around and south of Loewari Point, which is a spur of Mamoeja Mountain, there are sandy beaches, with great black rocks for some distance offshore. Mede, farther south, is marked by a waterfall. Southward of Goroea Point, near Mede, there is a long steep-to reef parallel with the coast. In the Tobelo lowlands there are coconut plantations. There are many coconut palms on the shore at the village of Wari.

Southward of this point is Tobelo, the largest village on the east coast of Halmahera. Tobelo Road is formed and sheltered by Koemoekoemoe Island and the reef which connects it to Halmahera (FIGURE IV - 18). The most conspicuous mark is a "zinc" roof at the southern end of the village and abreast the southern pier. On the westernmost of 2 drying reefs which lie southwest of Koemoekoemoe is the small islet of Madode. Tobelo village is situated along the western shore of the inner part of the roads. At the southern end of the village is a small pier, alongside which there is always sufficient water for boats. North of the village there is another pier with a depth of 8 feet alongside. Heavy volcanic ash is likely to fall during southwest winds. South of Tobelo the shore is a little swampy, with mangroves. (FIGURES IV - 19 to IV - 21)

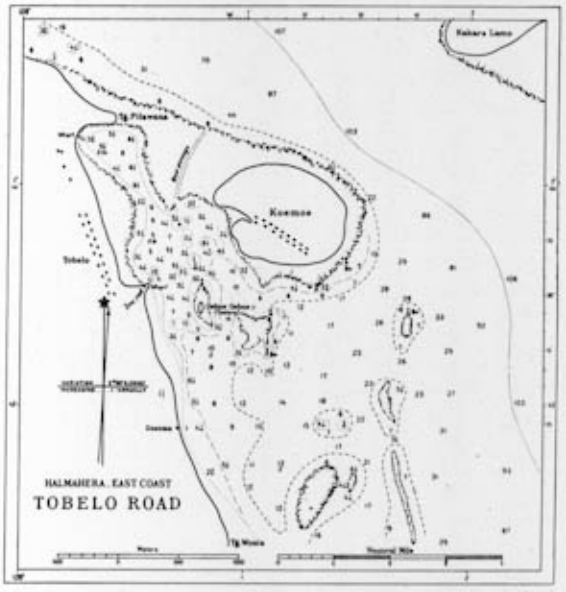

FIGURE IV - 18. *Halmahera Island, E coast.*
Hydrographic chart of Tobelo Road.

Miti Island, 9 miles southward of Tobelo, has Miti village on its western side and the village of Mawea on the shore opposite. (FIGURE XII - 15)

Between Loewari Point and Miti Island, 17 miles to the southeastward, lies a group of small islands known as Tobelo Islands. The largest of there are Tolonoeöe, Great Kokara, Tagalaja, Kolorai, and Miti. They are rocky coral islands, low, partly below sea level, and are covered with high forest trees and coconut palms. All of them are rocky to the east and northeast. Most of them have fringing reefs on the south and western sides. Rarangane, northeast of Tobelo, is so low that it is under water at extreme high tide. Kolorai is marshy in spots. Miti is wholly covered with vegetation.

FIGURE IV - 19. *Halmahera Island, E coast.*
Coast in vicinity of Tobelo, looking westward. 1939.

Although many of the beaches are fringed by rather wide reefs, the surf is seldom heavy and high-tide landings in shallow-draft landing boats can be made almost anywhere northward of Mawea and at Katana. Most of the Tobelo Islands, including Miti, are surrounded by beaches of rocky coral.

(3) Anchorages.

For anchorages at Tobelo and Miti Island, see Chapter VI.

At Popilo village, between the islets Mede and Popilo there is anchorage in 16 fathoms.

Anchorage is available in 16 fathoms outside the shoal patches at Wari.

Opposite Miti Island there is anchorage between Mawea and the village of Miti in 14 fathoms. The best approach is around the northern end of Miti Island, between the island and the drying reefs to the northward. Praus enter from the southward between Magalihoe and Goemoelamo, 2 small islets between the Halmahera shore and the southern end of Miti Island. Vessels can anchor close to the shore in the bight at Katana village, southwest of Miti.

There is anchorage in the bay northward of Pitoe (Efi Efi) near Tagaea Point, in 41 fathoms, as well as 3 miles southward of it in 11 fathoms, in the small bay near the village of Patja.

(4) Dangers to navigation.

The only detached danger outside the Tobelo Islands is Patola, covered by 1¾ fathoms, lying 1 mile east of Tagalaja Island. It is sometimes marked by discoloration and sometimes by breakers. There are several shoal patches lying in the inner roads at Tobelo, which can be distinguished by their brown color. The shoals in the vicinity of Miti are also well marked by discoloration.

(5) Landing beaches.

(a) Loewari Point beaches. (PLANS 5, 12, and 15, Section D(e)) Reliability POOR. Three small sandy beaches lie in breaks in the cliffs south of Loewari Point, 1° 49′ N, 127° 57′ E, the southern entrance point to Galela Bay. The area is recognized by a conical mountain, elevation 3,060 feet, which lies south of Loewari Point. The approach to the southern beach is obstructed by a number of large black rocks which extend quite far out. The approach to the 2 northern beaches is clear, but scattered rocks may exist in the area. All these beaches are lined with a narrow fringing coral reef. During the northwest monsoon waves break heavily on the beach. The beaches are composed of coral and volcanic sand with the latter predominating. Since a number of lava flows exist in the area, volcanic debris may be encountered on all of the narrow, steep, and moderately firm beaches. The land behind the beaches consists of a narrow plain which rises inland along the steep, wooded slopes

FIGURE IV - 20. *Halmahera Island, E coast.*
Coast in vicinity of Tobelo, looking northwestward. 1939.

of a mountain. The automobile road between Galela village and Tobelo village lies about 1,200 feet behind the beaches.

(*b*) *Tobelo beaches.* (PLANS 5, 12, and 15, Section C(f); FIGURES IV - 18 and IV - 21) Reliability FAIR.

1. Location and extent. Sandy beaches lie shoreward of the Tobelo Islands at Mede village, at Wari, and between Tobelo and Cape Baroe. It is possible, however, that the beach is continuous over the entire area from the mouth of the Mede River, 1° 46′ N, 127° 57′ E, to Cape Baroe, 1° 41′ N, 128° 01′ E. On approaching this stretch of coast the low Tobelo Islands, covered with tall trees, serve as an excellent landmark. The high mountains of Halmahera can also be seen from the seaward, including the twin-peaked Mede Mountain, which stands about 9 miles southwest of the area. Locally landmarks for the beach in the vicinity of Tobelo include the small islet, Madode, which lies about 2,000 feet east of the southern end of the village.

2. Nearshore. The approach to this stretch of coast is obstructed by the Tobelo Islands which are surrounded by numerous charted reefs and shoals (FIGURE IV - 21). Shoreward the approach to the northern end of the area is clear except for the islets, Mede and Popilo, which lie close offshore of Mede; a detached reef which lies north of Wari; and a number of shoal patches, which lie in front of Wari. South of Wari there are numerous charted detached reefs and shoals especially in the area fronting Tobelo. In general, heavy seas break along this coast during the northwest monsoon. The beach at Tobelo, however, is well protected from the winds and seas of this season. Currents along this stretch of coast are negligible.

FIGURE IV - 21. *Halmahera Island, E coast.*
Aerial view of Tobelo, looking NE.

3. Character of beach. The beaches in this area are composed of a mixture of coral and volcanic sand with the former becoming predominant as the southern end of the area is approached. In like manner, the beaches become firmer and a hard beach is reported to exist at Tobelo. All the beaches are steep and narrow. Two piers cross the beach at Tobelo, one at the northern end of the village and the other at the southern end. A number of streams, with bars at their mouths, cross the beaches within the area. The best places to land are at the villages of Mede, Wari, and Tobelo.

4. Adjacent terrain and exits. The land immediately behind the beach consists of a low, wide plain. The southern half of the plain is dry, but the northern half becomes marshy a short distance inland from the beach. At the inner edge of the plain the land rises along steep mountain slopes in the north, but in the south the slopes become moderate. Exit from the beach north of Tobelo lies along the automobile road which runs from Tobelo to Galela. South of Tobelo a trail follows the coast.

(*c*) *Pitoe (Efi Efi) beach.* (PLANS 5, 12, and 15, Section D(g)) Reliability FAIR. A sandy beach about 1 mile long lies in front of Pitoe (Efi Efi), 1° 39′ N, 128° 00′ E. It is possible, however, that the beach extends northward to the Oepa River and southward to Koepakoepa village. The approach to this stretch of beach is obstructed by a detached coral reef which parallels the shore in front of Pitoe (Efi Efi). Shoreward of the reef and northward and southward from its extremities the approach to the steep-to fringing coral reef is clear.

The beach is composed of coral and volcanic sand. It is narrow, firm, and steep. The best place to land is immediately north and south of the barrier reef off Pitoe (Efi Efi) village. Two streams cross the beach north of the village. In general the land behind the beach consists of a wide plain which rises inland along the steep, wooded slopes of the Tobelo Mountains. In the vicinity of Pitoe (Efi Efi) village, however, the plain is low and swampy. The path which parallels this stretch of coast lies immediately behind the beach.

(*d*) *Patja beach.* (PLANS 5, 12, and 15, Section D(h)) Reliability POOR. A sandy beach surrounds the point on which the village Patja, 1° 37′ N, 128° 00′ E, is built. It is possible, however, that the beach continues as far south as the village of Jaro. The approach to this beach area is obstructed by a large patch of coral reefs which lie east of Patja village. Northeast from the village the approach is clear to the fringing coral reef.

Heavy seas impinge on the reef during the northwest monsoon.

The beach, composed of coral sand, is firm, narrow, and steep, except near the Patja River mouth, which limits the western end of the beach. The land behind the beach consists of a plain which rises about 1 mile inland along the steep, wooded slopes of the mountains. The coastal trail lies immediately behind the beach. Another trail runs inland from Patja village to Patja Lake which lies about 3½ miles to the southwest.

(*e*) *Rangorango Point—Gonga Point beach.* (PLANS 5, 12, and 15, Section D(i); FIGURE IV - 22) Reliability POOR. An extensive sandy beach lies between Rangorango Point, 1° 36′ N, 128° 01′ E, and the northern limit of the cliffs surrounding Gonga Point, 1° 33′ N, 128° 02′ E. The area is recognized by Miti Island, which has a village, air strip, and jetty on its western side (FIGURE IV - 22). The islets, Magalihoe and Goemoelamo, lie southwest of Miti Island. The approach to the shore north of the islands should be made from the northeast, since a shoal area lies between Mawea village and Magalihoe islet, and the channels between the off-lying islands are suitable only for native canoes. South of the islands the approach to the shore is clear. Heavy seas are experienced in the area during the northwest monsoon. (FIGURE XII - 15)

The firm, steep, and narrow beach is composed of coral sand, except at the mouths of 2 large rivers which interrupt the beach, 1 just south of the village Mawea and the other just north of the village (Katana). The land behind the beach consists of a well-wooded plain which extends inland about 1 mile near the northern end of the area and then rises along moderate to steep slopes to the hills of the interior. Southward the hills become lower and the plain narrower. There are few trails in the area. The coastal trail from the north ends at Mawea village. Here a trail swings inland to Patja Lake and then makes a loop southward and eastward to Katana village. The shore area between the 2 villages is isolated by the Mawea and Katana Rivers.

F. Kaoe Bay.

(PLANS 3 to 5, 9, 13, and 14; FIGURES IV - 23 to IV - 33)

(1) Offshore zone.

The main channel leading into Kaoe Bay is close east of Bobale Island (PLAN 14). The maximum rate of the current on both sides of Bobale Island is 1½ knots. When the winds blow in a direction opposite to that toward which the current sets, a difficult sea is experienced.

At Kaoe Roads there is both a diurnal and a semidiurnal tide, but the latter predominates. The spring lows of the 2 tides may coincide. The lowest water level occurs between January and March and between July and October. The maximum rise and fall that can be expected are, respectively, about 2.6 feet above and 3.9 feet below mean sea level.

From the entrance of Kaoe Bay to Boleo Point, the 10-fathom curve lies about 2 miles from shore, but in the remainder of the bay is much closer. The inner part of Kaoe (Kau) Bay has a maximum depth of about 270 fathoms.

FIGURE IV - 22. *Halmahera Island, E coast.*
Miti Island and adjacent shoreline, looking NE. October 1943.

(2) Coastal topography.

The entrance of Kaoe Bay is 4½ miles wide at Bobale Island, 15½ miles south of Miti. It extends 33 miles southwestward to its head, which is separated from Dodinga Bay, on the west coast of Halmahera, by a narrow isthmus. Batoe Koehoe, a white patch at Domake Point, 10 miles north of Bobale Island, is conspicuous when the entrance to Kaoe Bay is approached.

Bobale Island, a low coral island covered with trees, is easily made out from the approach. There are conspicuous mountains on the western side of the bay, and the northwestern shore is rocky. The most conspicuous point on the eastern side of the bay is the highest summit (more than 3,800 feet) of the peninsula between this bay and Boeli Bay; it is located 19 miles east of Bobale. There are several other summits of 3,000 to 4,000 feet. Southwestward of Waisile Bay is a group of mountains, of which Soebaim, a sharply pointed 3,490-foot peak, is the highest. Southeast of it is the more gently sloping Wato Wato, 4,836 feet in height.

The northwestern shore of Kaoe Bay is, in general, rather low, with sandy beaches and mangroves around the mouths of the rivers. The southeastern shore is fairly high and steep with some exceptions. On the northwestern coast at Gamlaha village, where a missionary's light-colored house is conspicuous, and at Biang Point, 2 miles farther south, spurs extend from the hills. From Koesoe southward to Boleo Point, there is a gently-sloping beach outside of which is a wide reef, which dries at low water. Kaoe, a village built along the shore, is connected by a cart track northward to Pediwang, a distance of over 15 miles. Extending for 30 miles into the interior behind Kaoe is the largest plain area on Halmahera. Through it flows the Kaoe River. There is some marsh land in this area. The Kaoe River is the largest one on Halmahera Island and the only river navigable at high tide by boats drawing 3 to 4 feet. The bar of the river is awash at low tide. There is a channel through the reef opposite Djati village, through which praus and small boats pass to reach the wharf at Kaoe. All the mouths of the Kaoe River and the coast of the bay from this point southwestward are bordered by mangroves and nipa palms. The shore between Boleo Point close south of Kaoe and the western end of Kaoe Bay is low, but it is backed by low hills which gradually rise to the Mata Mata Mountains. At Boleo Point, the land falls steeply to the sea.

Southwest of Loleo Point around the Taolas River there is marshland, extending 2 or 3 miles into the interior. In the vicinity of Bobane Bay and Dodinga Isthmus, the coast line is hilly. On the southern coast of Kaoe Bay between the villages of Pintatoe and Ekor the land is low and swampy, with the largest swampy area extending 2 miles inland. South of Ekor are limestone heights which continue to Wasile Bay. From Ekor northward to Point Tolawi the coastal area is swampy, but little else is known about it. Akeselaka roads about 2 miles northwestward of the Islet Roni may easily be recognized by the little islet, Akeselaka.

(3) Anchorages. (See Chapter VI.)

(4) Dangers to navigation.

The main channel leading into Kaoe Bay close east of Bobale Island is deep in the fairway but has a 5½-fathom patch on its western side, and its eastern side is formed by a shoal bank with a least depth of 3½ fathoms. This shoal bank is separated from the reefs along the eastern shore of the entrance by another deep but narrow channel. The channel west of Bobale Island cannot be recommended on account of the several shoals and the currents. There are no off-lying dangers between Loleo Point and Biang Point.

A reef is reported to lie 1 mile north of the islet Akeselaka and about 870 yards offshore.

The eastern part of Leleo Lamo, the bight west of Boleo Point, contains a large bank that extends 1⅗ miles offshore. Ships in the vicinity of this bank should stay outside the 10-fathom curve.

(5) Landing beaches.

(a) Cape Patjikara beach. (PLANS 5, 13, and 14, Section E(a)) Reliability POOR. A possible sand beach about 7 miles long lies on the northern shore of Kaoe Bay, immediately southwestward of Cape Patjikara, 1° 19′ N, 128° 01′ E, the western entrance point to Kaoe Bay. The best landmark for the area is the tree-covered Bobale Island, which lies about 2 miles southeast of Cape Patjikara. The approach to this stretch of coast over a moderately sloping, stony, sand bottom is clear to the 30-foot depth, which lies about 5 miles seaward of the beach. The 18-foot depth lies about halfway between the 30-foot depth and shore. A sand bar, least depth about 11 feet, lies about 1,000 feet southeast of Daroe village close seaward of the 18-foot depth. Shoreward of the 18-foot depth, the shore is lined with a fringing coral reef which attains a width of about 4,000 feet at the southern end of the area. Landings are possible on this beach during both monsoons.

The beach is composed mainly of coral sand. It is narrow, firm, and steep. Numerous streams, the greatest number of which lie in the southern half of the area, cut across the beach. The land behind the beach consists, in general, of an extensive triangular plain whose base lies along the coast. North of this area the hills approach the coast, and the plain is only moderately wide; near the southern end the hills approach close to the coast, and the plain is extremely narrow. The greater portion of the plain is covered with coconut palms. Exit from the beach lies along a coastal trail which is situated immediately behind it. Another trail swings inland about 1 mile south of the village Biang and connects to the system of trails which traverses the valleys of the Kaoe River and its tributaries.

(b) Kaoe village beach. (PLANS 5 and 13, Section E(b); FIGURES IV - 23 to IV - 27) Reliability GOOD. A sand beach about 3 miles long lies on the west shore of Kaoe Bay, northward from Boleo Point, 1° 09′ N, 127° 54′ E. The best landmark for the area is Kaoe village which lies about 1 mile north of Boleo Point. The village is recognized by its low buildings, a pier which lies near its northern end, and a white beacon which stands on the shore north of the pier (FIGURE IV - 23). The approach to this beach area is clear over a gently sloping mud and sand bottom to the 30-foot depth, which lies about 1¾ miles seaward of the village Koesoe. South of this point it gradually approaches the shore until a minimum of about ¼ mile is reached off Boleo Point. A shoal, least depth 13½ feet, lies about 1 mile east of the pier at Kaoe. Nearshore an extensive reef lies off the northern end of the area. (FIGURE XII - 16)

The beach is composed of a mixture of sand and coral sand, with the latter predominating at the northern end of the area. It is narrow, firm, and steep (FIGURE IV - 24). Near the southern end of the area at Boleo Point a low eroded bank lies along the water line (FIGURE IV - 25). A pier 100 feet long crosses the

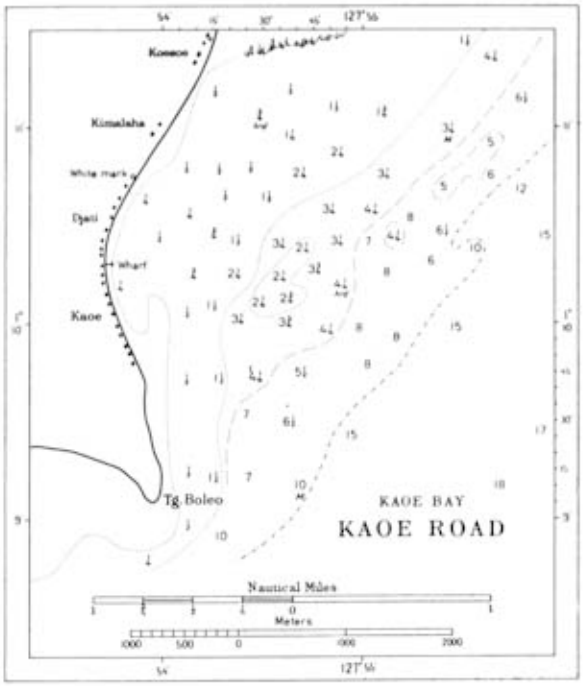

FIGURE IV - 23. *Halmahera Island, Kaoe Bay.* Hydrographic chart of Kaoe Road.

ridge of low hills approaches to within about ½ mile of the coast. Exit from the beach is by a coastal road which follows the coast from Kaoe north to Pediwang village. At Kaoe a trail trends westward following the coast about 1 mile inland and then returns to the shore at Kapita village. Numerous roads lead inland from the coastal road to the coconut plantations, but the one at the village of Kaoe leads to the air strip.

(*c*) *Kaoe River mouth beach.* (PLANS 5 and 13, Section E(c); FIGURE IV - 28) Reliability FAIR. A small sandy beach, cut near the center by a small stream, lies immediately west of the mouth of the Kaoe River about 2½ miles west of Boleo Point, 1° 09′ N, 127° 54′ E. The best landmark for the area is the mouth of the Kaoe River, which has numerous sand bars to the east. The approach to this beach area over a flat mud bottom is clear, but caution should be taken to avoid the shifting bars at the mouth of the Kaoe River which extend about 1⅔ miles offshore. This area is well sheltered from the northwest monsoon. The narrow, steep, firm, sand beach is interrupted near the center by a small tidal stream (FIGURE IV - 28). The beach is flanked on the east by the main mouth of the Kaoe River and on the west by the mouth of a branch of the same river (Plan 5). The land behind the beach is low, covered with jungle growth, and intersected by tidal streams. No apparent trails exist from this beach to the Kaoe air strip, which can be reached by motorboat at high water up the Kaoe River. Fresh water may be obtained from the river.

(*d*) *Malifoet beach.* (PLANS 5 and 13, Section E(d); FIGURE IV - 29) Reliability FAIR. A sandy beach about 1½

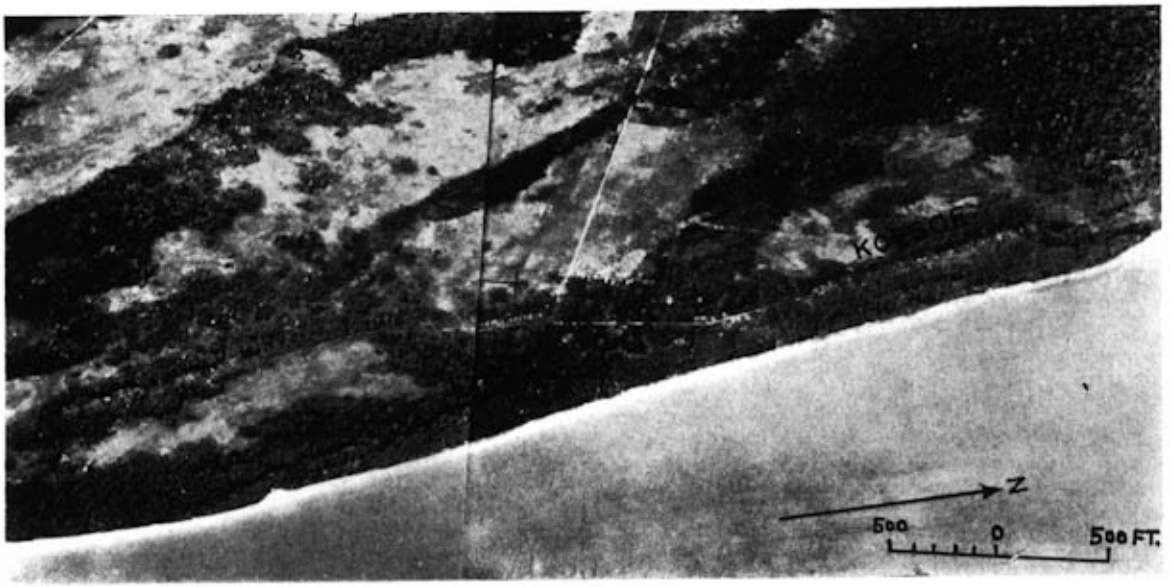

FIGURE IV - 24. *Halmahera Island, Kaoe Bay.* Beach N of Kaoe, looking W. 1943.

beach at the northern end of Kaoe village (FIGURE IV - 26). Fresh water may be obtained from the Kaoe River, which flows by the air strip behind the village (FIGURE IV - 27). The area behind the beach consists of the extensive coconut-covered plain of the Kaoe River valley, but near the northern end of the area a

miles long lies on the 2 sides of the village Malifoet, 1° 10′ N, 127° 50′ E. The best landmark for the area is a small pier, about ¾ mile southwest of Malifoet. Approach to this stretch of coast is clear, but shifting banks off the mouth of the Kaoe Rivers should be given a wide berth. River deltas and shifting

FIGURE IV - 25. *Halmahera Island, Kaoe Bay.*
Beach and low eroded bank in vicinity of Boleo Point, looking SE.

FIGURE IV - 26. *Halmahera Island, Kaoe Bay.*
Kaoe village, looking W. Road in background leads to airstrip. 1943.

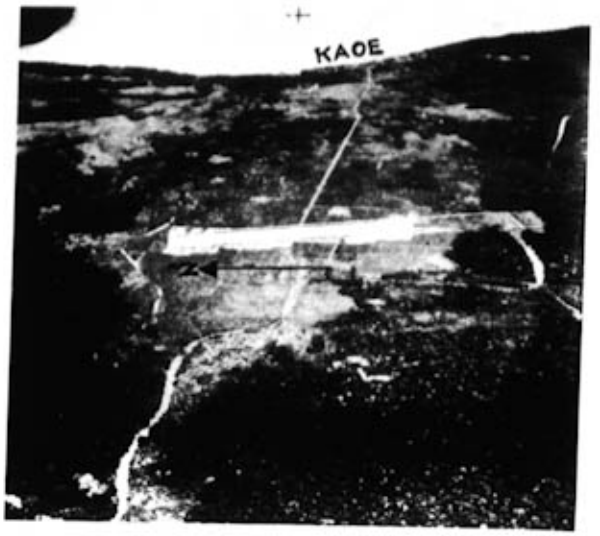

FIGURE IV - 27. *Halmahera Island, Kaoe Bay.*
Kaoe River, airstrip, and Kaoe village, looking E. 1943.

banks are found in the beach approach (FIGURE IV - 29). This area is well sheltered from the northwest monsoon.

The beach is composed chiefly of sand brought down by the Kaoe River and its branches. In the area between the streams, the beach is firm, but toward their mouths the mud content increases and the beach becomes soft. A small pier extends across the beach near the southwestern end of the area.

The land behind the beach is a low plain, which rises about 1 mile inland at the eastern end of the area as moderately well wooded slopes to the hills of the interior. Southwestward from this point, the plain becomes narrower and the hill slopes steeper. Exit from the beach lies along a trail which connects the pier and the villages along the shore. At the eastern end of the area, a trail swings a short distance inland and crosses the Kaoe River valley to the village Kaoe. In addition to this trail, one runs westward into the hills from the village Malifoet and another runs northward through the hills to the upper Kaoe River valley from the village Wangeotak.

(e) Akelamo beach. (PLANS 5 and 13, Section E(e)) Reliability POOR. A possible landing beach lies on the western shore of Kaoe Bay immediately south of Akelamo village, 1° 00′ N, 127° 38′ E. The approach to this beach area is clear to the 30-foot depth, which lies about 3,000 feet offshore. The 18-foot depth lies about 1,000 feet closer in. Shoreward, there is a fringing coral reef which varies in width from about 200 feet to 800 feet. The bottom material is sand near the northern end of the area, becoming muddy southward.

The narrow, firm, steep beach is composed of coral sand and debris. A stream cuts across the beach a short distance south of the village. The best place to land is near the stream mouth, where the reef is the narrowest. The land behind the beach is a low palm-covered river valley, which rises on both sides along moderate slopes to the hills of the interior.

Exit from the beach lies along the sand strand to the village. From Akelamo village a trail follows northward along the coast for a few miles and then swings inland behind a low, swampy, coastal area. Another trail runs inland from the village and joins the trail on the west coast of the island about 1½ miles south of Djailolo Bay.

(f) Goloek—Dowora Point beach. (PLANS 5 and 9, Section E(f)) Reliability POOR. A possible landing beach, locally interrupted by cliffs, lies on the west coast of Kaoe Bay between Goloek village, 0° 58′ N, 127° 38′ E, and Dowora Point, 0° 57′ N, 127° 39′ E. The approach to this beach area is clear to the 30-foot depth, which lies about 1,000 to 2,000 feet from shore. Shoreward the approach to the narrow sand beach is clear. Streams cross the beach at the northern and southern ends of the area. The best place to land is near the stream mouths. Except for local cliffs, the land immediately behind the beach rises along moderate slopes to the hills of the interior. There is no coastal trail in the area, but near the southern end a trail follows up the Lame River valley to the hills of the interior and thence across the island to Sidangoli village on the west coast.

(g) Bobane Bay beaches. (PLANS 5 and 9, Section E(g); FIGURES IV - 30 to IV - 32) Reliability FAIR. Three sandy beaches lie in the Bobane Bay area, 0° 53′ N, 127° 40′ E, on the southwest coast of Kaoe Bay. The first beach is situated within the entrance to the bay immediately behind Ritja Island.

The second, which is more extensive than the first, lines the entire southeastern shore of the bay. The third beach lies outside the bay, east of its entrance, in front of the village Pasirpoetih (FIGURE IV - 30). The approach to this beach area is clear. At the beach north of Ritja and at Pasirpoetih, there is a fringing coral reef. The sandy beach at Pasirpoetih is narrow, steep, and firm (FIGURE IV - 31), and the beach at Ritja is similar. The beach in the southeastern corner of Bobane Bay is moderately wide, moderately steep, and is composed of a mixture of mud and sand, which is soft in the vicinity of the stream mouth. A small pier is situated at Bobaneigoe village, which is at the western limit of the beach. The land behind the beaches in Bobane Bay is hilly, but at Pasirpoetih low land extends across the narrow neck of land which separates the beach from Bobane Bay. Exits from the beaches lie along the contours of the hills or

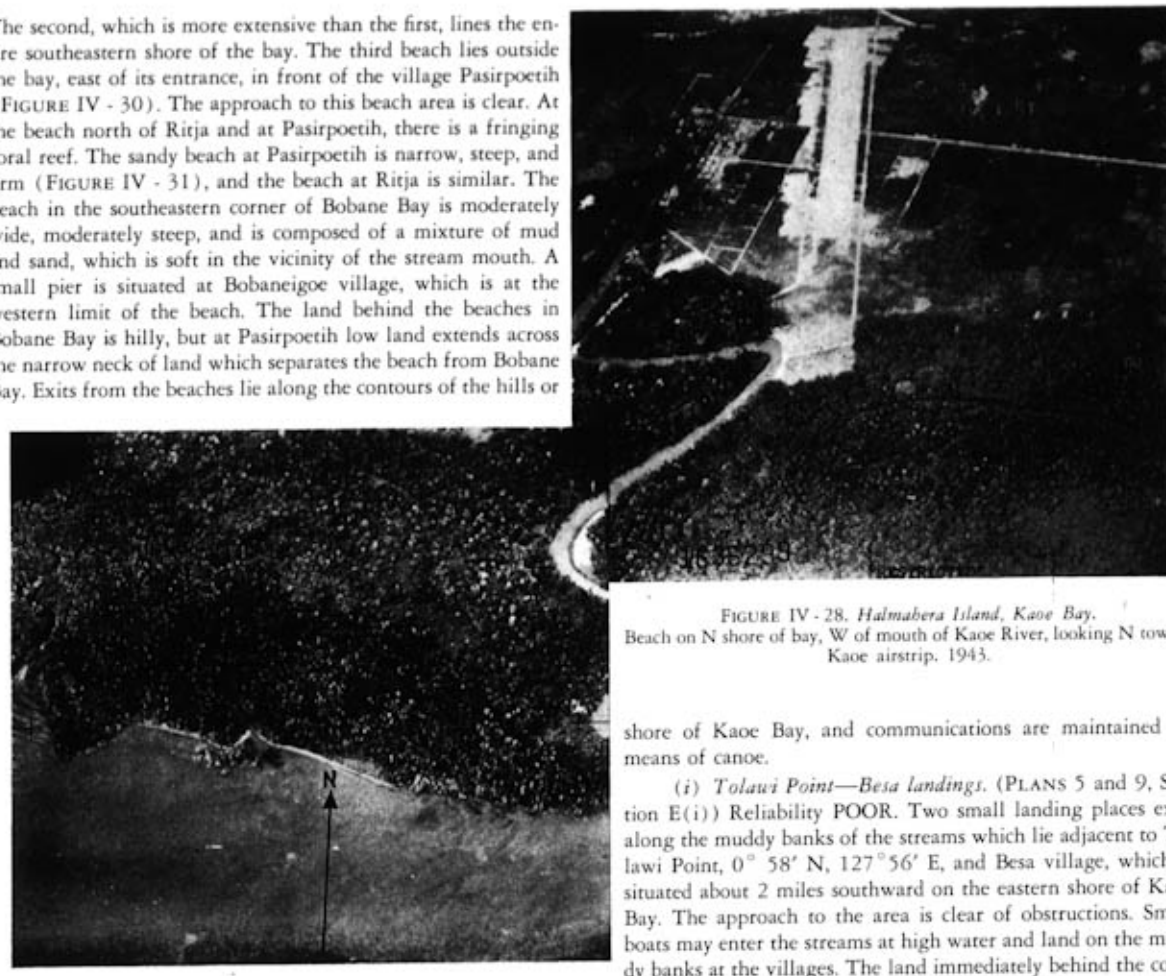

FIGURE IV - 28. *Halmahera Island, Kaoe Bay.*
Beach on N shore of bay, W of mouth of Kaoe River, looking N toward Kaoe airstrip. 1943.

across the low areas to the pier at Bobaneigoe. Here a road, moderately wide and with a firm bed (FIGURE IV - 32), trends southwestward across the narrow isthmus of the island to a landing beach at the head of Dodinga Bay.

(*h*) *Koesoe—Soot beaches.* (PLANS 5 and 9, Section E (h)) Reliability POOR. A number of small possible landing places exist along the mangrove-covered southern shore of Kaoe Bay, between the villages Koesoe, 0° 53′ N, 127° 42′ E, and Soot, 0° 54′ N, 127° 56′ E. The approach to this stretch of coast over a steep bottom of muddy sand is clear. The landing places, which exist at the villages, consist of muddy sand strands, which are firm enough to support a small boat. Near the village Ekor, it is reported that landings can be made in a stream mouth.

The terrain behind the shore at the eastern and western limits of the area consists of a narrow coastal plain, locally swampy, which rises inland along moderate to steep slopes. Toward the center of the area, the hills recede from the coast and the plain becomes extensive. A swamp exists near the center of the area at the mouth of the Paroeama River. Communications in this area are poorly developed. Trails lead from Mamin and Pintatoe villages at the western end of the area across Halmahera Island to Tonikoe-Islam village on Dodinga Bay. There are no trails connecting the villages on the southern shore of Kaoe Bay, and communications are maintained by means of canoe.

(*i*) *Tolawi Point—Besa landings.* (PLANS 5 and 9, Section E(i)) Reliability POOR. Two small landing places exist along the muddy banks of the streams which lie adjacent to Tolawi Point, 0° 58′ N, 127°56′ E, and Besa village, which is situated about 2 miles southward on the eastern shore of Kaoe Bay. The approach to the area is clear of obstructions. Small boats may enter the streams at high water and land on the muddy banks at the villages. The land immediately behind the coast between the 2 streams consists of a narrow, swampy area in front of an extensive plain. Trails traverse the plain connecting the villages in the area.

(*j*) *Akeselaka—Saloean beaches* (PLANS 5, 13, and 14, Section E(j); FIGURE IV - 33) Reliability POOR. A possible extensive sandy beach lies on the eastern shore of Kaoe Bay between the village Akeselaka, 1° 02′ N, 127° 57′ E, and Tobalien Point, about 5 miles north-northeastward. Another possible landing beach lies about 2 miles northeast of Tobalien Point in front of the village Saloean. The best landmarks for the area are Roni Island, 548 feet high and very conspicuous, which lies close to the shore about 2½ miles southwest of Akeselaka, and the small islet Akeselaka, which lies in front of the village of the same name (FIGURE IV - 33). The approach to this stretch of coast is clear over a sand and mud bottom, except for a reef which is reported to exist about 1 mile north of Akeselaka islet. A fringing coral reef lies along the shore in front of both beaches. The coral-sand beaches are firm, narrow, and steep. The best places to land are at Akeselaka, a storage place for jungle products, and at Wasile, a Netherlands government station. A number of streams cross the southern beach and one empties into the bay at the western end of the beach at Saloean village. The land behind both beaches consists of a narrow plain which rises along moderate to steep slopes to the hills

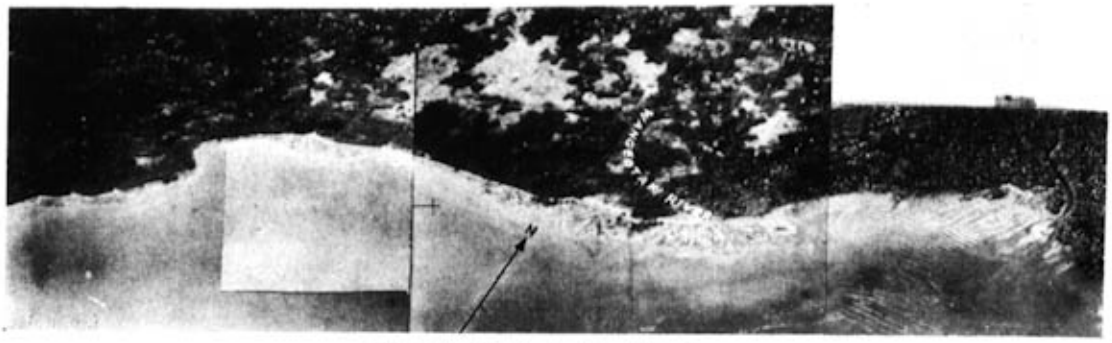

FIGURE IV - 29. *Halmahera Island, Kaoe Bay.*
Beach W of Wangeotak River, on both sides of Malifoet village, looking N. Note deltas at stream mouths. 1943.

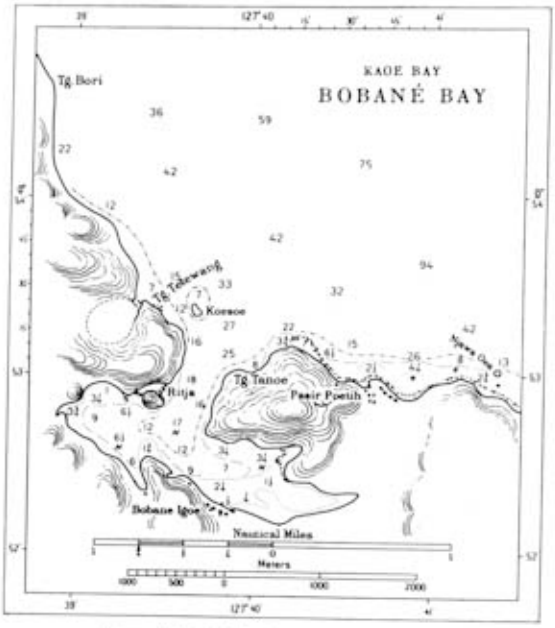

FIGURE IV - 30. *Halmahera Island, Kaoe Bay.*
Hydrographic chart of Bobane Bay at head of Kaoe Bay.

of the interior. Trails are almost lacking in the area, but the southern beach is joined to that on the north by a trail which runs northeastward from Wasile village.

G. Wasile Bay.

(PLANS 5 and 14; FIGURE IV - 34)

(1) Offshore zone.

The main channel leading into Kaoe Bay and Wasile Bay is close east of Boebale Island. It is deep in the fairway but has a 5½ fathom patch on its western side; its eastern side is formed by a shoal bank with a least depth of 3½ fathoms. This shoal bank is separated from the reefs along the eastern shore of the entrance by another deep but narrow channel.

The maximum rate of the current on both sides of Boebale Island is 1½ knots. When the winds blow in a direction opposite to that toward which the current sets, a difficult sea is experienced.

FIGURE IV - 31. *Halmahera Island, Kaoe Bay.*
Beach at Pasir Poetih, on SW shore of Kaoe Bay, looking E. 1928-29.

Depths in Wasile Bay range from 7 fathoms near the shore to 34 at the entrance.

(2) Coastal topography.

On the south side of the bay the coast is rocky. On the east side there is a wide mud bank. Farther northward the shore becomes sandy and narrower. There is a beach at the village of Lolobata, but rocks lie close ashore off the village. Lolobata Point, the northern tip of Wasile Bay, is steep, fronted by sandy strips. The most extensive known beach area is on the southern shore from Toimi Point to the village of Moeman. (FIGURE XII - 14)

(3) Anchorages. (See Chapter VI.)

(4) Dangers to navigation.

Wasile Bay is clear. The only dangers in the vicinity are the shoals eastward of Boebale Island.

(5) Landing beaches.

(a) Goeroea beaches. (PLANS 5 and 14, Section E(k); FIGURE IV - 34) Reliability FAIR. Numerous sandy beaches separated by stretches of rocky coast lie on the south shore of Wasile Bay surrounding Goeroea Point, 1° 08′ N, 128° 06′ E. The approach to this area is clear over a mud and sand bot-

tom. On the exposed sections of the coast there is a wide, fringing, coral reef, which diminishes in width and finally disappears at the head of Goeroea Bay (FIGURE IV - 34). The area is well sheltered from the winds and seas of both monsoons. The beaches are composed of coral sand. They are narrow, firm, and steep. At the head of Goeroea Bay, 2 short piers lie across the beach. The best place to land is at the head of the bay near the piers where exits from the beach are available. The heavily wooded land behind the beaches rises along gentle to moderate slopes to the hills of the interior. A road runs inland from the piers and warehouse area to the village Goeroea which lies on the slopes a short distance inland.

(*b*) *Head of Wasile Bay beaches.* (PLANS 5 and 14, Section E(1)) Reliability POOR. Numerous stretches of possible sandy beach lie at the head of Wasile Bay, especially near the villages south of Dodaga Point, 1° 09′ N, 128° 10′ E. In the area about 5½ miles north of Dodaga Point, 2 landing jetties extend seaward over the narrow, fringing, coral reef. It has been reported that 3 additional landing jetties have been built in this area. The approach to this stretch of coast over a gradually sloping mud bottom is clear to the shore, which is lined by a bank on the south and by a fringing coral reef of varying width on the north. The area is well protected from the winds and seas of both monsoons. The beaches are composed of a mixture of mud and sand with sand and coral sand becoming more prominent toward the northern end of the area where the landing jetties are located. One of the jetties has a "T" head and 2 have "L" heads.

The terrain south of the jetties consists of a wide well-wooded plain which gives way several miles inland to the steep slopes of the mountainous interior. In the vicinity of the jetties, low, wooded, undulating hills approach close to the shore. In the southern part of the area, trails lead inland from the various beach areas. At Dodaga village a trail trends southeastward across the island to Boeli village on Boeli Bay. Immediately behind the jetties there is a military barracks area, reported to be connected by a road to Lolobata air strip, which lies about 6 miles northwestward.

(*c*) *Lolobata beach.* (PLANS 5 and 14, Section E(m)) Reliability POOR. A sandy beach lies in front of the village Lolobata, 1° 15′ N, 128° 07′ E, on the north coast of Wasile Bay. Westward and northward from the village, it is possible that other small beaches lie along the coast of the peninsula, which forms the eastern entrance point to Kaoe Bay. The approach to this stretch of coast is obstructed by a bank of shoals which lies in the entrance to Kaoe Bay. Shoreward of these shoals the approach is clear to the edge of the fringing coral reef which is about 1,000 feet wide at Lolobata. Westward the reef narrows but northward off Njaolako Point it becomes extensive. The narrow, firm, steep beaches are composed of coral sand. A stream crosses the beach at Lolobata immediately west of the village. A jetty is reported to lie near the eastern end of the village. The land behind the beach is low and well wooded. An air strip, 4,600 feet by 500 feet, has been constructed about 2½ miles north of Lolobata village on the opposite side of the peninsula. Although a trail is known to exist between the villages on the peninsula, it is reported that roads lead from the village Lolobata and the various jetties mentioned in the previous paragraph to the air strip. (FIGURE XII - 14)

H. Morotai Island.

(PLANS 3, 5, and 15 to 17; FIGURES IV - 35 to IV - 41)

(1) Offshore zone.

High seas and rollers from the southeast and northeast have been experienced. The inhabitants reported that landing is practically impossible during the north monsoon except at Berri Berri, Boesoe Boesoe, and Sangowo. Strong currents may be experienced off the northeast end of the island. At Gorango Point a rate of 3 knots has been observed at times, with a rising tide.

The channel between the islet Mitita and Dehegila Point has a least depth of 4½ fathoms; the deepest water will be found

FIGURE IV - 32. *Halmahera Island.*
Road SW from Bobane Bay across narrow isthmus to Dodinga Bay, looking N. 1933.

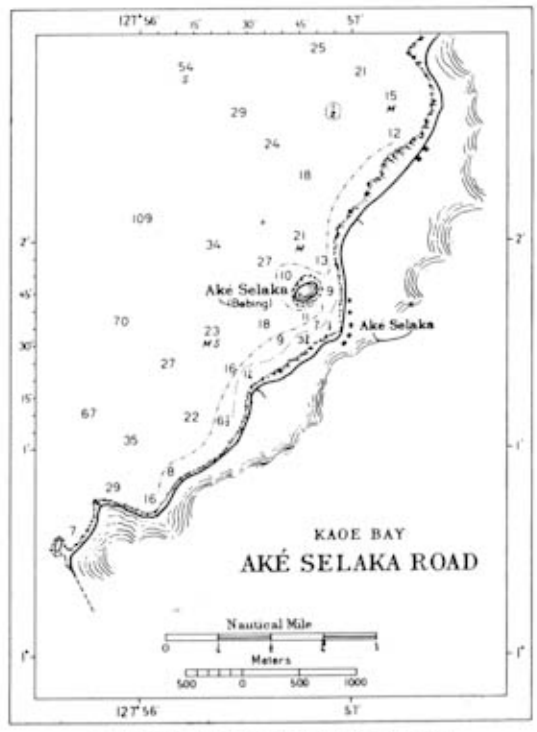

FIGURE IV - 33. *Halmahera Island, Kaoe Bay.*
Hydrographic chart of Akeselaka Road.

FIGURE IV - 34. *Halmahera Island, Kaoe Bay.*
South shore of Wasile Bay. 1943.

on the alignment of the eastern points of Kokoja and Kolorai in range bearing 342°.

The west coast of Morotai between Point Dehegila and Wajaboela, a distance of 18 miles, is fronted by numerous shoals, reefs, and islets, which lie up to 5 miles offshore. The reefs are well marked by discoloration, and the passages within them are available to vessels of considerable draft.

Southeastward of Wajaboela Point is a slightly indented bight, which forms a harbor about ¾ mile in diameter and 18 fathoms deep in the center. The harbor is protected on the south and southwest by 3 drying coral reefs, roughly circular, which are about ½ mile in diameter. The best approach to the anchorage is between the westernmost drying reef and the ½-fathom shoal south of it, and then between the former and the reef eastward of it.

Rao Strait, between Rao and Morotai Islands, is a little over 1 mile wide at its narrowest part, but in that section it is further restricted by a shoal with a least depth of 4¼ fathoms extending 1,600 yards from the Rao shore, a shoal with a least depth of 3¾ fathoms extending 800 yards from the Morotai shore, and by a 3¾-fathom shoal lying between the above two. Of the 2 channels thus formed, the northern is the deeper. There are no navigational marks for these channels, but they are marked by tide rips.

(2) Coastal topography.

Morotai Island, lying about 10½ miles eastward of the northern end of Halmahera, is about 40 miles long and is high over its greater part. The highest point, elevation 4,101 feet, is one of the summits of the Sabatai Range, which stretches across the island in a northeasterly direction. On the river banks and on the flat southwestern part of the island are forests of sago trees and in the interior are dammar forests. Along the coast are a number of villages. Near the east coast a ridge of more or less conspicuous hills rises to heights of 900 to 1,610 feet. Back of them are the higher Sabatai Mountains. Along the northern part of this coast, between Point Sopi and Selepia Point, a distance of 15 miles, the shore reef is steep-to; thence southward to Point Posi Posi, a distance of 20 miles, the greater part of the bank of soundings is foul and has a barrier reef fronting the coast in places. Berri Berri anchorage is located in a bight of the coast 2¼ miles southwest of Point Selepia. Between Point Boboro and Boesoe Boesoe village, 5 and 12½ miles southward of Berri Berri, a deep and sheltered channel lies between the barrier reef and the coast. At Point Lefau, where a conspicuous small rock lies on the coast reef, a wide break is found in the barrier reef. A white sandy beach extends northward from this point. Excellent drinking water can be obtained from a well.

Along the south coast, between Point Posi Posi and Dehegila, a distance of 20 miles, the narrow coast reef is steep-to. There is a protruding tongue of shoal water with a least depth of 3 feet, 4½ miles southwest of Point Posi Posi. At Sangowo, close west of Point Posi Posi, there is a small basin in the drying coast reef, which has depths of 3 to 5½ fathoms and is available to small vessels. There were 2 private beacons*, one on the western side of the entrance, the other on the shore at the head of the basin. Sabatai village, 8½ miles west of Sangowo, is at the mouth of the river of the same name, which can be navigated by praus.

On the west side of Morotai, there is nothing particularly conspicuous about the mountains, with the possible exception of Bandera, a 495-foot coastal hill 8 miles north of Dehegila Point. The latter is a low, wooded tongue of land. Near a pair of conspicuous palm trees on the west side, not very far north of the point, praus can easily approach the beach at any state of the tide. They usually wait here for favorable weather conditions before rounding the point.

Mitita is a thickly wooded coral island 1¾ miles southwest of Dehegila Point.

Kokoja, Kolorai (Tagalaja), Little Dodola, and Big Dodola Islands are situated on a drying reef, which lies 2½ to 8½ miles northward of Mitita. The 2 northernmost of these islets are not inhabited, but are covered with coconut plantations; they may be reached from Kolorai by foot at low water. Between these islets and the shore to the eastward is another group of islands including Soemsoem, Roekiroekita, Bobongonmahaharong, Roeberoebe, and Loengoeloengoen. The village of Doroeba lies on the coast southeast of the latter.

On the next large drying reef to the northward lie the islets, Big Loleba, Little Loleba, Big Galogalo, and Little Galogalo; on them are some houses and coconut plantations. Close west of Big Galogalo is the small islet of Pelo. The large village of Dowongi Kokotoe lies on the coast abreast this group and at the foot of Bandera hill. Little Ngelengele, and Big Ngelengele, on the northernmost of the larger reefs, have large villages and coconut plantations. On the coast abreast of the latter islet is Tilai village, with the inhabited islet of Katjoewawa close off it.

The coast along Wajaboela Point and the bight to the southeastward of it is fringed by a narrow drying reef. There are many cocount palms in this area. There is a 3-mile stretch of coastal plain in the vicinity of Wajaboela Point. Northward, beyond this coastal plain, the coast of Morotai is steep-to, with a narrow fringing reef in places.

(3) Anchorages. (See Chaper VI.)

(4) Dangers to navigation.

The bight of Berri Berri is sheltered by a large drying reef on which is the mangrove-covered island of Tabailengi. The entrance between this reef and another drying reef to the northward is not safe, owing to the several shoals which do not show by discoloration. The least water, a depth of 1¼ fathoms, is found on a shoal 1,300 yards north of Tabailengi Island. Dangers are found near the coast both north and south of the barrier reef. The outer danger in the vicinity of Mitita off Dehegila Point is a 4¼ fathom patch, Pono Ponato, 1¾ miles west of Mitita. A similar patch lies about 1 mile farther north, and a drying reef lies between them and the islet.

(5) Landing beaches.

(a) Sangowo—Sambiki beaches. (PLANS 3, 5, 15, and 16, Section F(a); FIGURE IV - 35) Reliability POOR. Sandy beaches are situated in front of the large villages of Sangowo and Sambiki which lie close together at the southeast corner of Morotai Island. It is possible that the beaches are continuous. The area is at about 2° 06′ N and between 128° 32′ E and 128° 33′ E. Landmarks for the village of Sangowo include a conspicuous house with a "zinc" roof, a beacon which marks the western side of the entrance to the basin in the drying coastal reef (FIGURE IV - 35), and a beacon which is situated on the shore at the head of the basin. The approach to this stretch of coast is clear of dangers to the 30-foot depth, which lies about ¼ mile from the shore at both beaches. Shoreward of the 30-foot depth the approach to the beach at Sangowo, which lies at

*In this chapter, description of lights and other man-made navigational aids is stated in the past tense, on the basis that such aids would not be available in wartime. All other description is in the present and represents the best information available in Washington, D. C., in April 1944 when the chapter was being prepared. Many of the structures mentioned may have been damaged or destroyed.

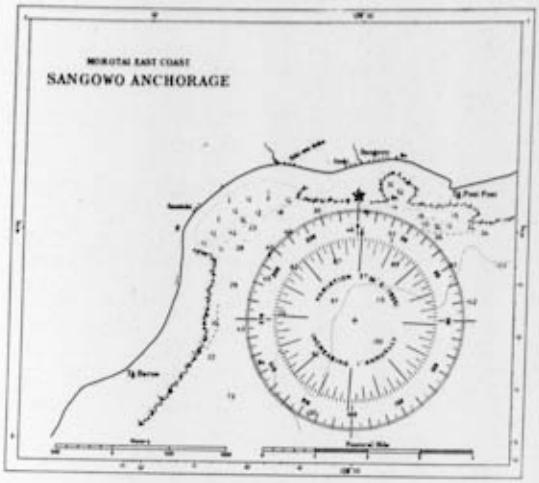

FIGURE IV - 35. *Morotai Island, E coast.* Hydrographic chart of Sangowo Anchorage.

the head of the previously mentioned basin, is clear to the seaward edge of the fringing coral reef. The reef in front of the village is about 500 feet wide. The approach to the beach at Sambiki village is clear shoreward of the 30-foot depth over a gently sloping sand bottom. Here there is a break in the fringing reef about ¾ mile long. The beaches are composed of coral sand. The western beach is interrupted by a stream near its eastern end; the eastern beach is interrupted by a stream immediately west of Sangowo village. Boats can always land safely in the basin at Sangowo but a heavy swell may be encountered from October to March. High seas and rollers have been experienced from the southeast. The beaches are sheltered during the north monsoon. The land behind the beaches is relatively low but rises quickly to the uninhabited mountainous interior. The villages are connected by a good road 10 to 13 feet wide with wooden bridges and culverts.

(*b*) *Pinang Point—Pitoe Bay beaches.* (PLANS 3, 5, 15, and 16, Section F(b)) Reliability POOR.

1. Location and extent. Many sandy beaches lie along the south coast of Morotai Island between Pinang Point, 2° 04′ N, 128° 31′ E, and Pitoe Bay, 2° 02′ N, 128° 17′ E. The best landmark for the area is the low, wooded tongue of land, Dehegila Point, which projects about 4¾ miles southwestward from the island at the western end of the area.

2. Nearshore. The approach to this stretch of coast, over a steep bottom, is clear to the seaward edge of the narrow, steepto, fringing, coral reef, except for a protruding tongue of shoal water, least depth 3 feet, which lies about 1¼ miles southwest of Pinang Point. Offshore the bottom is stony near the eastern end of the area, becoming progressively sandier toward the west. The weather conditions may vary widely from year to year and from season to season. High seas and rollers have been experienced from the southeast. Heavy showers from the southsoutheast occur at the middle of the south monsoon. They come up suddenly about 10 or 11 a. m. and are accompanied by a heavy sea.

3. Character of beach. The beaches are composed of coral sand and are interrupted by numerous streams, most of which are located in the central part of the area. The narrow coastal reef which generally lines the shore is an aid to landing. In the vicinity of Sabatai-Baroe village, 6½ miles west of Pinang Point, there is a break in the fringing reef about 1½ miles wide. The Sabatai River, immediately west of the village, is the largest river in the area. It has a shallow bar at its entrance and is navigable by small boats. Two streams flow into the bight in which the village of Doewo is situated. Here there is a break in the reef about 1 mile wide.

4. Adjacent terrain and exits. The beaches are backed by coconut palms which fringe the south coast of the island. West of Momodjioe village, which is located 3¼ miles west of the mouth of the Sabatai River, the land behind the beaches consists of a flat plain, 3 to 5 miles wide, that extends northwestward as far as the Pilowo River. It is covered with forests of sago trees with open, grassy plains near the coast. East of Momodjioe village the land rises gradually from a narrow coastal plain to the steep ridges of the mountainous interior. Exit from the beaches may be had along a coastal trail, about 6½ feet wide, which leads west to the village of Doroeba and connects with the sandy beach on the western side of the promontory which terminates in Dehegila Point. The coastal trail is known to exist as far east as Doewo village and possibly connects with the villages along the east coast of the island. It could probably be used by light trucks except near the Sabatai River, where it is too steep. There are no bridges, but the rivers, with the exception of the Sabatai, are fordable at low tide. The south coast is well populated and numerous villages are situated along the shore. A trail leads to the interior along the banks of the Sabatai River. Other trails lead inland a short distance. A grass-covered air strip has been reported near the eastern end of the area. Water is obtainable from wells.

(*c*) *Dehegila Point beach.* (PLANS 3, 5, 15, and 16, Section G(a); FIGURE IV - 36) Reliability FAIR.

1. Location and extent. A beach lies along the western shore of the low wooded tongue of land which projects from the southwestern end of Morotai Island and terminates in Dehegila Point, 1° 59′ N, 128° 15′ E. The village of Doroeba, 2° 03′ N, 128° 17′ E lies at the northern limit of the beach. Landmarks for the area include numerous scattered reefs and islets which lie from 1 to 6 miles offshore; Bendere Mountain (elevation 495 feet), a conspicuous coastal hill, which is located about 8 miles north of Dehegila Point; and a couple of conspicuous palm trees, which are located a short distance north of the same point. The reefs are well marked by discoloration.

2. Nearshore. The approach to this stretch of coast is obstructed by the reefs and islets mentioned above and by numerous charted rocks and shoals (FIGURE IV - 36). The 30-foot depth lies about ¼ mile offshore at the village of Doroeba. South of this point it gradually approaches the shore until it coincides with the fringing coral reef about 1 mile north of Dehegila Point. Shoreward of the 30-foot depth the approach to the beach over a sand bottom is clear to the seaward edge of the narrow coastal reef. It is reported that landing here is extremely difficult during the north monsoon. During the southeast monsoon Dehegila Point presents much difficulty; the surf is worse here than at any other part of the island.

3. Character of beach. The beach is composed of coral sand with debris occurring locally. It is narrow, steep, and firm. Near the 2 conspicuous palm trees a short distance north of Dehegila Point, landings can easily be effected at any stage of the tide. There is a jetty at the village of Doroeba. (FIGURE XII - 20.)

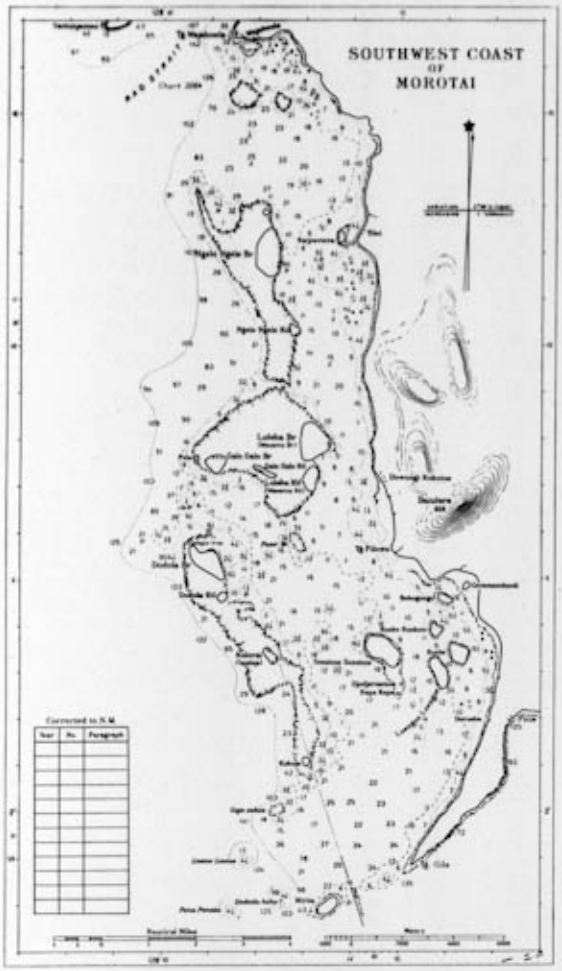

FIGURE IV - 36. *Morotai Island.*
Hydrographic chart of SW coast.

4. Adjacent terrain and exits. The land behind the beach consists of a low, wooded promontory, ¾ mile in greatest width, with coconut palms along the shore. Several villages are situated along this stretch of coast. To the northeast the promontory merges with a flat coastal plain, about 4 miles wide in this vicinity, which is covered with rain forest and has open grassy plains near the coast. It is reported to be firm and well drained. Exit from the beach may be had along a coastal trail, about 6½ feet wide, which leads northward along the promontory to the village of Doroeba and then eastward along the south coast of the island. Inland from Doroeba village a clearing for a new air strip has been reported. Water is obtainable from wells in the villages.

(*d*) *Pilowo beach.* (PLANS 3, 5, 15-17, Section G(b); FIGURE IV - 36) Reliability POOR. A sandy beach possibly exists in front of the village of Pilowo which is situated on the southwest coast of Morotai Island about 8½ miles north of Dehegila Point. The area lies at 2° 07′ N, 128° 15′ E. Landmarks for the beach include a number of islets and reefs which lie from 1 to 5 miles offshore in this vicinity and a conspicuous hill, Bendera Mountain (elevation 495 feet), which is located about 1¾ miles east of the area. The islets are low and are in general covered with coconut palms. The reefs are well marked by discoloration.

The approach to this stretch of coast is obstructed by the above-mentioned reefs and islets and by several charted shoals (FIGURE IV - 36). The 30-foot depth lies about 3,000 feet to 1 mile offshore. Shoreward the approach is clear over a flat sand bottom to the seaward edge of the coral reef which lines the northern half of the area. The reef is narrow at the northern end of the area, widens to about 2,000 feet near the center, and disappears into the sandy shore along the southern half of the area. It is reported that landing is practically impossible during the north monsoon.

The beach is composed of coral sand, with debris probably occurring locally. It is narrow, firm, and steep and is interrupted by 2 streams; one near the center and the other near the northern end. It is backed by coconut palms and a coastal plain not more than 1 mile wide which merges with the extensive plain to the southeast. To the northeast it rises along moderate slopes to the mountains of the interior. Exit from the beach is possible along a trail which leads inland from Pilowo village along the banks of the Pilowo River and joins a system of mountain trails, which connects with different parts of the island. The trail branches southeastward across the coastal plain to the Tjao River.

(*e*) *Tilai Point vicinity beaches.* (PLANS 3, 5, 15-17, Section G(c); FIGURE IV - 36) Reliability POOR. Two possible beach areas are situated on the southwest coast of Morotai Island; one around Tilai Point, 2° 12′ N, 128° 14′ E, on which the village of Tilai is situated, and one about 2 miles north of this point. The beaches are separated by a strip of marshland. The area is recognized by Big Ngelengele Island and 2 smaller islands which lie on an extensive reef about 1¾ miles from shore opposite Tilai Point. The small island, Katjoewawa, lies about ¼ mile off the same point.

The approach to this stretch of coast is obstructed by the reef and islets mentioned, by a charted shoal, least depth 3 feet, and some rocks and detached reefs (FIGURE IV - 36). South of Tilai Point the 30-foot depth lies about 1½ miles offshore. Northward it swings abruptly shoreward and lies about 2,000 feet offshore at the village of Tilai. Shoreward of the 30-foot depth the approach to this beach over a sand and stone bottom is obstructed by the islet Katjoewawa, with its fringing coral reef, and by some rocks and detached reefs which lie south of Tilai Point. The shore in this beach area is lined with a coral reef. At the northern beach the 30-foot depth lies 1,000 feet to 2,300 feet offshore. Shoreward the bottom shoals rapidly and the approach is clear of dangers. A fringing coral reef exists along the southern half of the area but disappears in the sandy shore along the northern half. Landing in the entire area is practically impossible during the north monsoon. Heavy surf is encountered at the middle of the south monsoon.

The beaches are composed of coral sand with debris occurring locally. They are narrow, steep, and firm. The southern beach is interrupted by the Tilai River north of the village Tilai and the northern beach is interrupted by a stream near its northern end. They are backed by coconut palms. The land behind the beaches consists of a coastal plain ¾ mile to 2½ miles wide rising inland along moderate to steep slopes. A trail leads inland along the banks of the Tilai River to the upper reaches of the Goergoerina

River. A trail leads a short distance inland from the northern beach.

(f) Wajaboela Point—Toetoehoe beaches. (PLANS 3, 5, 15-17, Section G(d); FIGURES IV - 37 to IV - 41) Reliability GOOD.

1. Location and extent. Sandy beaches are situated around Wajaboela Point, 2° 17′ N, 128° 12′ E and at the village of Toetoehoe, 3½ miles to the northeast. Possibly the area between these 2 beaches is also sandy beach. The best landmark for the area is Raoe Island (elevation 1,558 feet), which lies about 1¼ miles northwest of Wajaboela Point. Its highest summit is conical in appearance when seen from the southwest. Additional landmarks include a conspicuous tree which stands at Wajaboela Point and a house with a "zinc" roof, in Wajaboela village, just west of the point.

wide at Wajaboela Point. It is reported that landing is practically impossible during the north monsoon. Heavy seas are encountered at the middle of the south monsoon.

3. Character of beach. The beach at Wajaboela is composed of firm, coral sand (FIGURES IV - 38 and IV - 39). It is very narrow at high tide and has a slope of about 1 on 8. Locally it is interrupted by low banks supported by the roots of coconut palms (FIGURE IV - 40). About ½ mile west of the point there is a small jetty built of stones and sand with the outer end of wood. The best place to land is either side of the jetty at high water.

4. Adjacent terrain and exits. The beach is backed by coconut palm plantations and the houses of the village. Inland there is a plain 1 to 2½ miles broad rising along moderate to steep slopes. A surfaced vehicle road runs around the point. A

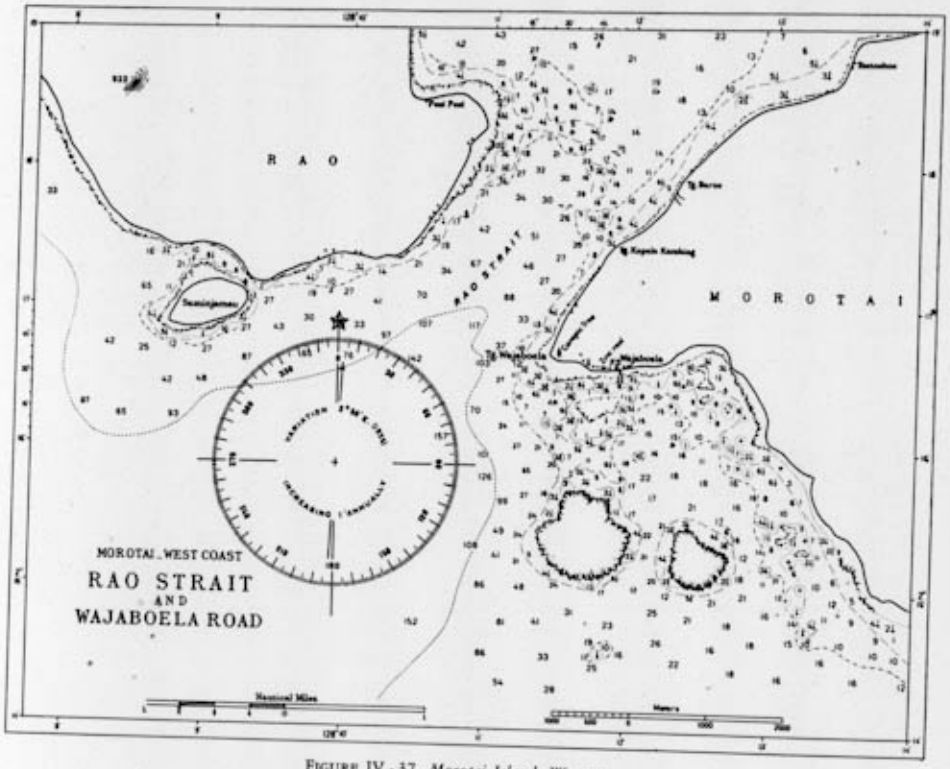

FIGURE IV - 37. *Morotai Island, W coast.*
Hydrographic chart of Rao Strait and Wajaboela Road.

2. Nearshore. The approach to the beach at Wajaboela village is obstructed by several detached reefs and charted shoals (FIGURE IV - 37). The approach to the area north of Wajaboela Point lies through Raoe Strait, which is restricted in its narrowest part by several shoal banks. The channels between these shoals are marked by tide rips. At the village of Wajaboela the 30-foot depth swings seaward around a detached reef to a distance of about 3,300 feet from shore. Shoreward of the 30-foot depth, which lies at distances varying from 300 to 1,600 feet over the remainder of the area, the approach is clear to the seaward edge of the fringing coral reef which is about 900 feet

trail possibly leads to the village of Toetoehoe. At Toetoehoe the beach is interrupted by the mouth of a small river. The material brought down by the river extends in a broad delta over the fringing coral reef (FIGURE IV - 41). The beach is soft and flat and is composed of a mixture of sand, coral sand, and mud with debris occurring locally. It is backed by jungle with scattered coconut palms and secondary growth along the shore. Inland are gentle slopes merging southward with the coastal plain behind Wajaboela Point. Well water is obtainable at Wajaboela but is brackish and not clean.

FIGURE IV - 38. *Morotai Island, W coast.*
Beach at Wajaboela. 1939.

FIGURE IV - 39. *Morotai Island, W coast.*
Narrow beach at Wajaboela, looking E. Same area as FIGURE IV - 40.
1939.

FIGURE IV - 40. *Morotai Island, W coast.*
Shore at Wajaboela, showing low banks. Same area as FIGURE IV - 39.
1939.

FIGURE IV - 41. *Morotai Island, W coast.*
Mouth of Toetoehoe River, showing shifting sand bars of delta, looking NE. 1932.

42. *Sangihe-Talaud Islands*

The Sangihe Islands and the Talaud Islands are the principal units of an archipelago lying between the northeastern point of Celebes and the island of Mindanao. The Islands are almost entirely volcanic.

A. Sangihe Islands: Lipang Island.
(PLAN 18)

The Sangihe Islands lie between 2° and 4° N, and 125° and 126° E. They include Sangihe Island and all the islands south of it to Biaro Island. They are heavily wooded and mountainous, but in places along the coast they are low and flat, and even swampy on Sangihe. The islands will be discussed in approximate order from north to south, beginning with Lipang Island.

(1) Offshore.

Approach to Lipang Island is clear except for a 6½-fathom shoal 750 yards east-northeast of the steep northern point.

(2) Coastal topography.

Lipang Island, about 10 miles north of Sangihe Island at 3° 55′ N, 125° 23′ E, is 591 feet high, and is easily recognized from all sides by its pointed summit, which is covered with vegetation.

(3) Anchorages.

Although the bottom is steep and the water is deep off Lipang Island, anchorage can be found off a village near a beach located on the southwestern shore. Currents in this possible anchorage are irregular. A better anchorage can be found north of the island, although it is much farther offshore.

(4) Dangers to navigation.

A 6½-fathom shoal lies 750 yards east-northeast of the steep northern point. About 8 miles north-northwest of Lipang Island lies Louisa Bank with a least depth of 6 fathoms. A considerable current, which gives rise to a violent sea, sets across the bank.

(5) Landing beaches.

(PLAN 18, Section A(a)) Reliability POOR. A small sand beach lies in front of the village on the southwestern shore of Lipang Island. The approach to the beach is clear through deep water over a steep bottom, to the fringing coral reef. During the north monsoon, the winds often shift suddenly from northeast to west. West winds usually persist for a number of days. With this condition prevailing, a heavy surf breaks on the fringing coral reef. The currents in the vicinity of the beach are irregular. The water temperature is always greater than 70° F. The beach is composed mainly of coral sand and debris eroded from the coral reef. The beach is firm due to cementation, and can be reached by small boats at high water over the reef. The land behind the beach rises along the steep coconut-covered slopes of the main peak of the island. Communication with the other islands is maintained by small boats.

B. Sangihe Islands: Sangihe Island.
(PLAN 18)

(1) Offshore zone.

A 2-knot current has been experienced along the west coast of Sangihe Island, outside of the bays. The coast is generally steep-to, small reefs extending offshore only in a few places.

At Tahoena Bay there is both a diurnal and a semidiurnal tide, but the latter predominates. The spring highs of the 2 tides coincide. The highest water level occurs in May and November.

The maximum rise and fall that can be expected are, respectively, about 3.6 feet above and 2.6 feet below mean sea level.

Tamako Roads, 7 miles south of Manganitoe Bay, is not so well sheltered from southerly winds as Tahoena Bay.

On the east coast the strait between Sangihe and Beng-darat Island, south of Lebessan, is broad and deep, but a 7½-fathom shoal lies in mid-channel and a coral reef extends from Beng-darat. Between the latter and Beng-laoet Island is a deep passage; the shore reefs are easily made out. North and east of Beng-laoet are a large number of bare rocks. The islands are hilly, but without any conspicuous summits. A current, with a velocity of 3 knots at springs, may be experienced in the strait between Sangihe and Beng-darat Island; it sets northward with the flood and southward with the ebb.

Manaloe Roads, in the bay formed by Lebessan, Batoewing-koeng, and Tehang Islands, is nearly always calm. There is both a diurnal and a semidiurnal tide, but the latter predominates. The spring highs of the 2 tides coincide. The highest water level occurs in May and November. The maximum rise and fall that can be expected are, respectively, about 4.3 feet above and 3 feet below mean sea level.

Peta Bay is narrow between the shore reefs (FIGURES IV - 42 and IV - 43), but the depths decrease gradually.

FIGURE IV - 42. *Sangihe Island, NE coast. Peta Bay.*
Partially uncovered reef to port on entering Peta Bay, looking SE.

steep and rocky, and thence to Tahoena Bay the land slopes more gradually down to the shore, with sand and stone beaches. No dangers have been reported along this part of the coast.

Tahoena Bay (FIGURE IV - 44) is lined with high hills which are covered with trees. The bay is about ½ mile wide and extends 1⅓ miles inland. Except for the shore reef on the southern side and the shore bank at the northeastern corner, there are no dangers in the bay, so it can be entered even at

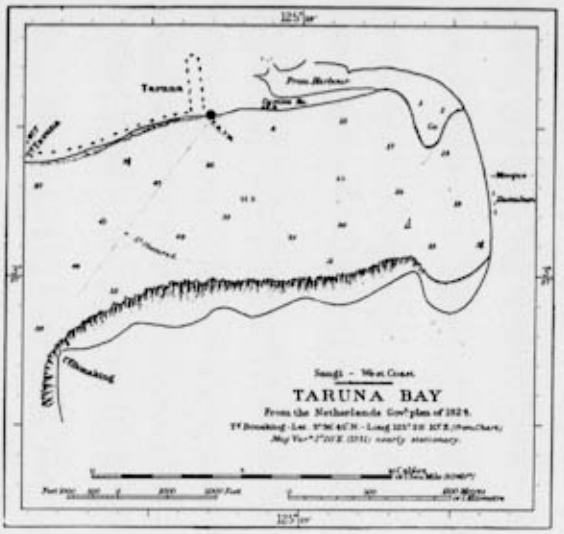

FIGURE IV - 44. *Sangihe Island, W coast. Tahoena Bay.*
Section from BA chart 930.

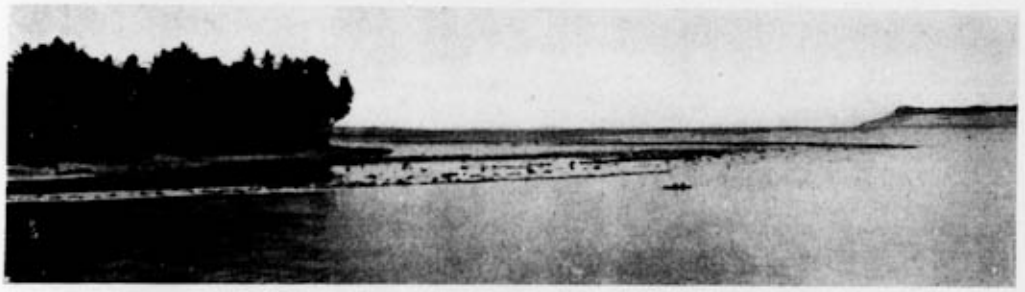

FIGURE IV - 43. *Sangihe Island, NE coast. Peta Bay.*
Partially uncovered reef to starboard on entering Peta Bay, looking NE.

At Taboekanlama Bay the depths outside the 30-fathom curve increase rapidly, but within that curve they decrease gradually toward the reefs and shore. The roads are open from southeast by south, through east to north.

(2) Coastal topography.

Sangihe Island is the largest island of the group. It is 26 miles long, and rises to a height of 6,102 feet in Mount Awoe, which is a flat-topped active volcano. The coast varies greatly; it has several bays, is steep and rocky in places, and low and even swampy in others.

The west coast, from Point Salimar—the northern point of Sangihe Island—to about 1 mile southward of Point Maseli, is

night with clear weather. The 1,706-foot hill, close south of Tahoena Bay, is rather conspicuous. Tahoena village is the principal village of the Sangihe Islands. There was a small landing pier for boats; at low water it has a depth of 3 feet alongside.

Manganitoe Bay (FIGURE IV - 45), 2 miles south of Tahoena Bay, is bordered by hills, 650 to 800 feet in height, which are covered with trees. The coast between the 2 bays is steep and rocky, and is fringed by a drying reef in several places. In the southern part of the bay the shore reef extends about ½ mile off, with a 1¼-fathom spot outside it; this spot is often marked by discoloration.

The coast between Tamako Roads and Manganitoe Bay is, for the most part, steep and rocky.

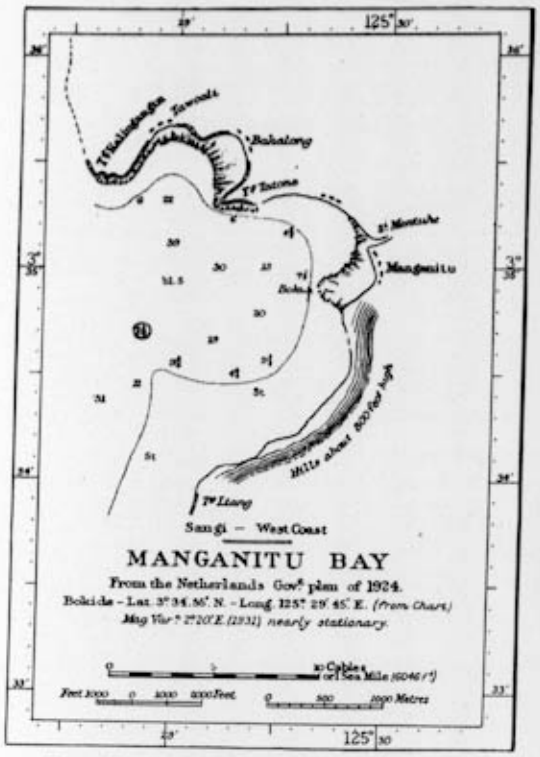

FIGURE IV - 45. *Sangihe Island, W coast. Manganitoe Bay.*
Section from BA chart 930.

Dagho Bay (FIGURE IV - 46), in the southern part of Sangihe Island, is entered between Toade Manandoe Island and Mahoemoe Island. The latter is hilly, and is separated from the main island by a channel that can only be used by small native boats. The summit of this island has an elevation of 791 feet. Within Sama Island, a small islet off the northern shore of Mahoemoe Island, it is always calm. A small channel with over 6 feet of water leads to Kaloewatoe, near the head of the bay, but the water is not transparent and the coral reefs outside the channel are covered with mud. At Dagho Bay a stone mole extends out across the drying shore reef.

Bebalang Island, 1½ miles west of the southern end of Sangihe Island, is a hilly island rising to a height of 430 feet. A large tree stands on its summit. A navigable channel separates the island from Sangihe Island.

Lenggis Island eastward of the entrance to Ngalipaëng Bay, is separated from the Sangihe coast by a narrow passage, navigable by native boats at high water.

Ngalipaëng Bay (FIGURE IV - 47), on the southeast side of Sangihe Island and 2½ miles north of the southern end of that island, is calm only during the north monsoon. On the northwestern side of the bay is the fairly large village of Ngalipaeng.

The southern end of Sangihe Island was formerly a peninsula, but is now an island separated from the main island by a narrow channel that dries at low water.

South of Lebessan Island the east coast is very high, rocky, and irregular. North of Lebessan as far as Peta, it is steep and rocky, but northward from the latter place it slopes gradually.

South of the strait between Sangihe Island and Beng-darat Island is Dane Island, a steep rocky islet with a very narrow coastal reef. It is separated from Sangihe Island by a deep passage.

Peta Bay (FIGURE IV - 48) was marked by 2 cross beacons, one on the shore and the other on the slope of a hill, forming an entrance range when in line on the bearing 222°.

The north coast of the island, between Taboekanlama and Point Salimar, slopes gradually toward the interior, except at the stretch near the villages of Kaloesaga and Sawang, where it is steep and rocky.

(3) Anchorages.

Anchorages, at Tahoena Bay, Tamako Roads, Dago Bay, and Peta Bay are described in Chapter VI.

Manganitoe Bay has a safe anchorage in a depth of 33 fathoms with Point Tatone bearing north and the small islet Boekide bearing east. However, westerly and southerly winds are as troublesome here as in Tahoena Bay.

Ngalipaeng Bay has anchorage in 38 fathoms of water with the flag pole bearing 334° and the southwestern entrance point bearing 180°.

Off the village of Saloerang, on the coast south of Lebessan, there is anchorage in 30 fathoms of water with the southwest point of Beng-darat Island bearing 124°, and the white rocks north of Beng-laoet Island bearing 69°, but this location is rather close to the reef. Landing is difficult during the north monsoon.

At Manaloe Roads anchorage will be found about 600 yards offshore in a depth of 17½ fathoms. Handling cargo is rather difficult on account of the gradual inclination of the beach.

Koeloer Bay (FIGURE IV - 49), 2 miles west of Tehang Island, affords anchorage in depths of 11 to 19 fathoms in its outer part. The village of Koeloer is difficult to reach because of the drying shore reef.

Koema Bay, 1 mile farther to the northwestward, affords good anchorage in 7½ fathoms of water, with the southern entrance point bearing 134° and the center of the village 223°. There is much surf on the beach during the north monsoon.

Talengen or Mioeloe Bay (FIGURE IV - 50), close northwest of Koema Bay, affords sheltered anchorage in 30 to 35 fathoms. The village is hardly visible; landing is difficult on account of the shore reef, the mud, and the mangroves.

Sensong Bay, 3 miles north of Koema Bay, is calm and affords good anchorage, but the reefs which skirt the shore almost everywhere make landing hazardous.

Taboekanlama (FIGURE IV - 51), about 1½ miles northwest of Peta Bay, affords anchorage in 14 to 19 fathoms, with the flag pole at the village bearing 236°.

The depths along the north coast permit anchoring almost anywhere, but there is no shelter. One can anchor in 27 to 38 fathoms about 325 yards offshore abreast Sawang, which is not visible from seaward. During westerly storms and the north monsoon, landing on the beach is very difficult.

(4) Dangers to navigation.

At Tahoena Bay there are no dangers, except for the shore reef on the southern side and the shore bank at the northeastern corner.

In the southern part of Manganitoe Bay, the shore reef extends about ½ mile off, with a 1¼-fathom spot outside it; this spot is often marked by discoloration.

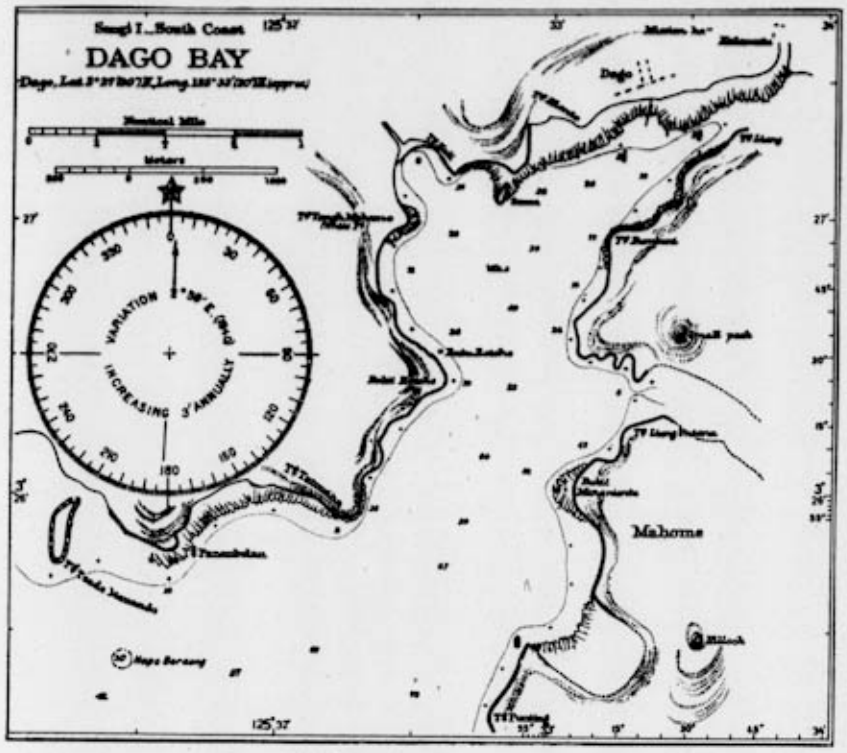

FIGURE IV - 46. *Sangihe Island, S coast. Dagho Bay.*
Section from HO chart 3061.

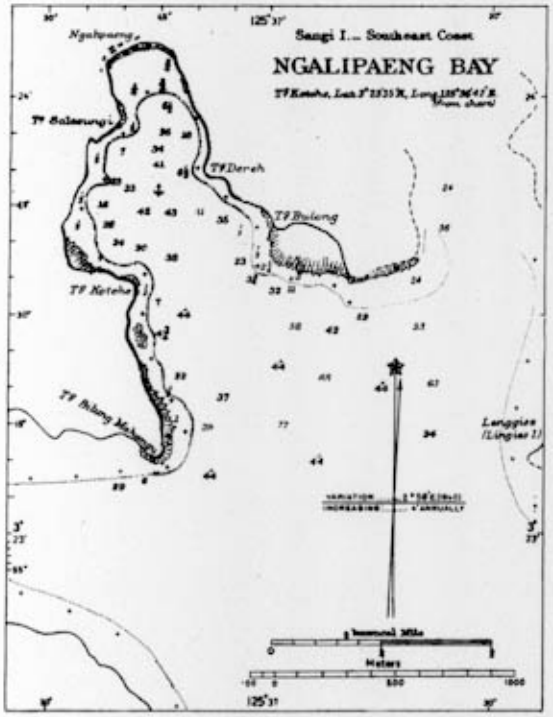

FIGURE IV - 47. *Sangihe Islands, S coast. Ngalipaeng Bay*
Section from HO chart 3061.

On the east coast, a 7½-fathom shoal lies in mid-channel of the strait between Sangihe Island and Beng-darat Island.

In Manaloe Roads a shoal with a least depth of 4¾ fathoms lies in the channel southeast of Tehang Island. As a heavy sea will be encountered in this channel during the north monsoon, it is advisable not to use it at that time. A detached rock off Kembono Point, in the channel between that point and Tehang Island, dries at low water. Another reef is charted near the middle of the bay.

(5) Landing beaches.

(*a*) *Tariang beach.* (PLAN 18, Section B(a)) Reliability POOR. Three narrow landing beaches exist in breaks in the high rocky northwest shore of Sangihe Island at the villages of Tariang, 3° 43′ 30″ N, 125° 25′ E, Talawide, 3° 43′ N, 125° 24′ 30″ E, and Kendahe, 3° 41′ 30″ N, 125° 24′ E. The best landmark for the area is G. Awoe volcano, elevation 6,102 feet, which lies about 4 miles east-southeast of the general area. The volcano is recognized by its slopes, broken by ravines and gorges. The approach to the shore in this general area is clear and the bottom gradient steep. Westerly winds, which often last 1 to 4 days during the north monsoon, create high seas and heavy surf along the shore. At other seasons westerly winds are not as severe. A current of about 2 knots has been experienced along the coast. The water temperature is always greater than 70° F. Beaches existing in this area are narrow, steep, and composed of volcanic sand and pebbles. Streams empty into the sea at the villages of Tariang and Kendahe. The area behind the beaches is covered with coconut palms through which runs a path con-

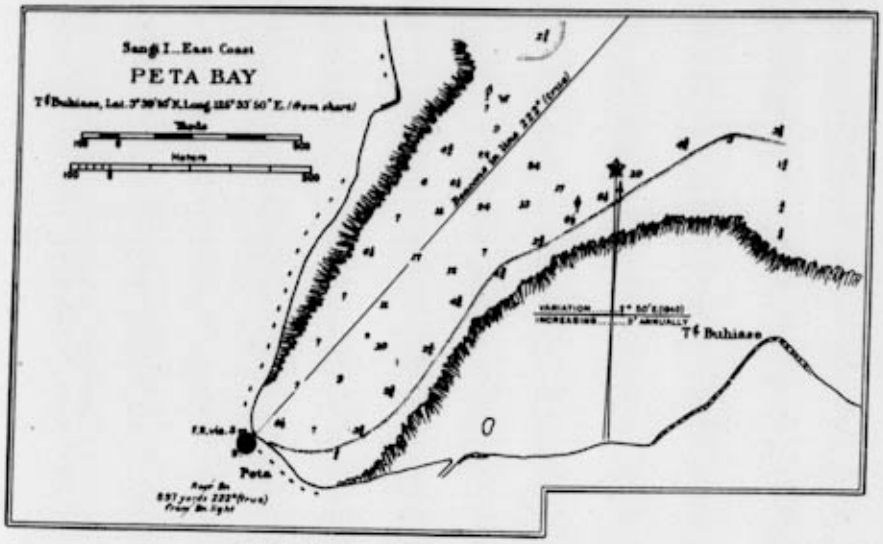

FIGURE IV - 48. *Sangihe Island, NE coast. Peta Bay.*
Section from HO chart 3061.

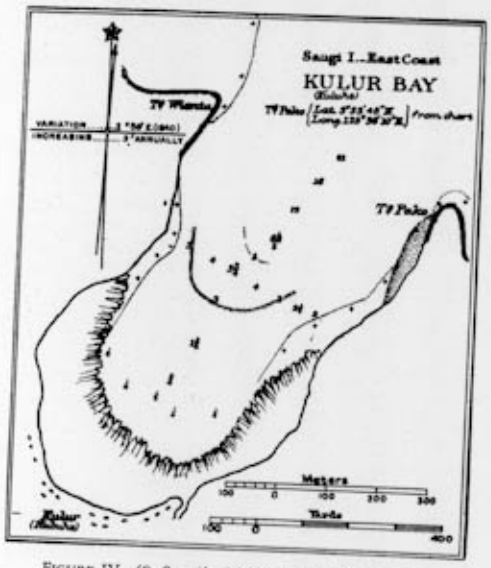

FIGURE IV - 49. *Sangihe Island, E coast. Kooloer Bay.*
Section from HO chart 3061.

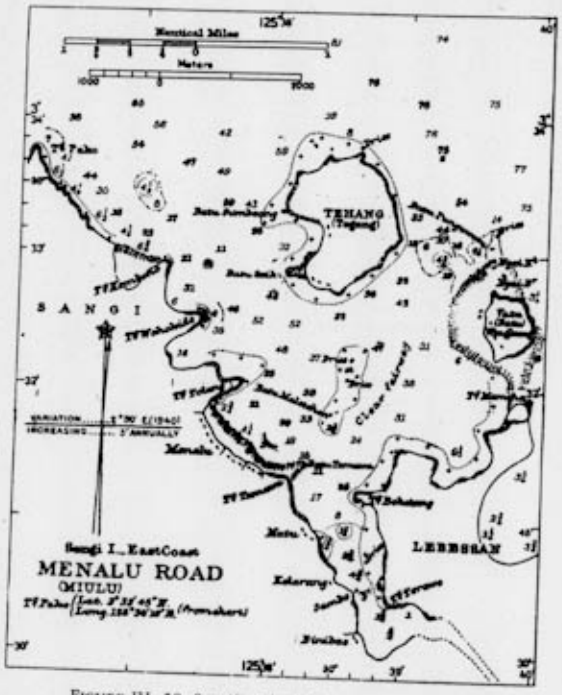

FIGURE IV - 50. *Sangihe Island, E coast. Manaloe Bay.*
Section from HO chart 3061.

necting the villages. Immediately inland from the path the land rises steeply in the slopes of Mount Awoe.

(*b*) *Akembawi—Tahoena segment beaches.* (PLAN 18, Section B(6)) Reliability POOR.

1. Location and extent. A narrow beach about 7 miles long, interrupted by numerous stream mouths, fronts a narrow coastal plain at the foot of the southern slopes of Mount Awoe volcano from Akembawi village, 6° 38′ 30″ N, 125° 25′ E, southeastward to the head of Tahoena Bay, 3° 37′ N, 125° 29′ E. The eastern end of the beach is recognized by a small pier which is situated in front of the village Tahoena, a light which is occasionally shown from an iron support on the inner end of the pier, a large, substantial, coral, concrete church which

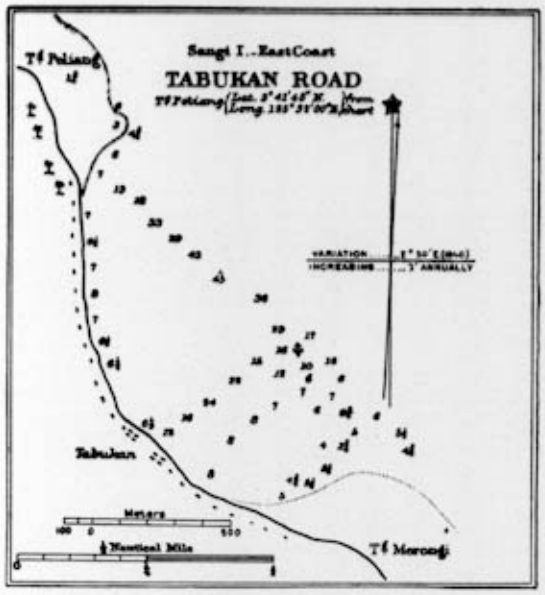

FIGURE IV - 51. *Sangihe Island, NE coast. Taboekanlama Bay.* Section from HO chart 3061.

stands about 2,000 feet west of the pier, and the customs house with flagstaff which stands about 1,000 feet east of the pier. An additional aid in recognizing the bay is a conspicuous 1,706-foot hill which lies close to its southern shore.

2. Nearshore. The approach to this beach area is clear of dangers except for a coral sand shore bank, least depth 6 feet, which lies at the entrance to a small lagoon at the head of the Tahoena Bay. During operations in the bay caution should be taken to avoid the wide fringing coral reef on its southern side. The bottom in this beach area has a steep slope and is composed of loose volcanic sand. During the north monsoon season the winds often veer suddenly to the westward, persist for from 1 to 4 days, and create heavy seas along the coast. At other times of the year west and southwest winds are not as severe but may hinder the transfer of cargo in the Tahoena Bay where a swell usually runs even with easterly winds. There are no currents in the bay but a current of about 2 knots has been experienced along the coast outside. The tide in the Tahoena Bay is both diurnal and semidiurnal, the latter predominating. The spring highs of the two coincide. The highest water elevation may be expected in May and November. The maximum rise and fall that may be expected are respectively about 3.6 feet above and 2.6 feet below mean sea level. The water temperature is always greater than 70° F.

3. Character of beach. The beach in general is narrow, steep, and composed of volcanic sand and stone. The surf on the beach is extremely heavy when the waves are driven by strong westerly winds during the north monsoon season. Numerous streams flow across the beach northwest of the entrance to the Tahoena Bay. Landings can easily be made within the bay, where the beach is composed of sand and is free of debris. The beach near the village is 30 to 40 feet wide and is not encumbered by a fringing coral reef. A small pier in front of the village, with 3 feet of water alongside, and the entrance to a lagoon in the northeast corner of the bay interrupt the beach.

4. Adjacent terrain and exits. Inland from the beach lies Awoe volcano whose steep timber-covered slopes descend to a narrow coastal plain which is covered with coconut palms. Exit from the beach is by a wagon road which runs close behind the beach from its northwestern end southeastward to the village of Tahoena. This section of road is a link in a system of roads and paths which completely encircles the island close to the shore. From the village of Tahoena a cart road leads northeastward across Sangihe Island to the villages of Kaloerae and Likoepang on its northeastern shore. There was a radio station at Tahoena village.

(*c*) *Manganitoe beach.* (PLAN 18, Section B(c)) Reliability POOR. A small beach lies in front of Manganitoe village, 3° 34′ N, 125° 30′ E, at the head of Manganitoe Bay which is situated about 2 miles south of Tahoena Bay. The best landmark for the area is the steep rocky coast which separates the 2 bays. The approach to the beach is obstructed by a 1¼-fathom patch which lies slightly more than a mile west-southwest of the village (FIGURE IV - 45). The entire bay is lined with a shore reef which varies in width from about 1,500 feet off the village, to about 1 mile off the southern shore of the bay. The bottom material seaward of the reef is black sand. Westerly winds and waves make landing difficult. The water temperature is always greater than 70° F.

The beach which lies in front of Manganitoe is a narrow coral strand fronted by a fringing coral reef which dries about 1,000 feet off the southern end of the village. The best landing place is north of the village at the mouth of the Beowono River where small boats can reach the beach at high water through a break in the reef. At other points in the vicinity landing can be made directly on the reef flat except during westerly winds when the surf is extremely heavy. Shoreward of the beach the head of the bay is surrounded by a group of hills 650 to 800 feet high. These hills form the backbone of the island. Their slopes are entirely covered with vegetation. The coastal trail which trends northward and southward lies at the foot of the slopes immediately behind the beach. From the village of Manganitoe a trail trends eastward across the island to Mioeloe village. A branch from this trail leads northeastward to the landing place at Peta village.

(*d*) *Central west coast beaches.* (PLAN 18, Section B(d)) Reliability POOR. Five possible landing beaches lie in front of the villages of Paghoeloe, Kaoehise, Sesiwoeng, Lebo, and Barangkalang in breaks in the steep rocky stretch of coast which lies between the bay of Manganitoe, 3° 34′ N, 125° 30′ E, and the bay of Tamako, 3° 27′ N, 125° 30′ E. The approach to these landing beaches is clear but the shore is lined with a fringing coral reef whose maximum width is about 1,500 feet. These beaches are exposed to westerly winds and seas which are violent during the north monsoon season. The water temperature in this area is always greater than 70° F. The beaches are narrow coral strands which lie at the upper limit of the reef and can be reached by small boats at high water during an easterly wind. During a westerly wind the surf breaks heavily on the reef. The best place to land would be near the stream mouths which exist at each village since there is usually a break in the reef at these places. The land behind the beach is covered with trees, and rises steeply from a very narrow coastal plain to the crest of a ridge of hills. The highest peak, elevation 3,000 feet, lies about 2 miles east of the village of Kaoehise. At the foot of the slopes and immediately behind the beaches a path which completely

encircles the island runs along the coastal plain connecting the villages in adjacent areas.

(*e*) *Tamako beach.* (PLAN 18, Section B(e)) Reliability POOR. A beach about 2,000 feet long lies at the head of the bay of Tamako, 3° 27′ N, 125° 30′ E, in front of the small village of the same name (FIGURE IV - 52). A flag pole stood behind the beach. The village was a regular port of call for Dutch vessels before the war. The approach to the beach is clear. The bottom offshore is composed mainly of rock with sand occurring locally; its slope is gentle enough to afford good anchorage. Strong westerly and southerly winds create a high sea in the bay. The water temperature is always greater than 70° F. The beach is composed mainly of volcanic sand brought down by the river which enters the bay near the southern end of the beach. Immediately behind the beach there is a narrow coastal plain which extends inland up the gently sloping floor of the stream valley. To the northwest and southeast the land rises steeply from the floor of the valley to mountain peaks. On the low area behind the beach there is a hard-surfaced road about 20 feet wide which extends a short distance north and south of the village where it connects to the coastal path which encircles the island.

(*g*) *Dagho Bay beaches.* (PLAN 18, Section B(g)) Reliability POOR. Landing can be made at the villages of Dagho and Kaloewatoe, in the northeast corner of the bay of Dagho, which lies at 3° 27′ N, 125° 33′ E. The bay is recognized by hilly Mahoemoe Island, elevation of summit 791 feet, which lies on the southeastern side of its entrance. The western entrance point of the bay is rocky and has a small island west of it. The approach to Dagho village is clear to a stone mole which extends across the drying reef. The approach to Kaloewatoe, where there is a small landing place, is through a 6-foot channel whose entrance is encumbered by a coral reef which is obscured with mud. The volcanic sand bottom in the bay slopes gently. Southerly and westerly winds create rough seas in the entrance to the bay, but eastward of the island Sama in the bay it is always calm. The shores of the bay are lined with mangroves. Immediately behind the head of the bay there is a narrow plain from which the land rises in moderate slopes to the surrounding tree-covered hills. The main coastal path leads through both villages. At Kaloewatoe village a trail swings inland along the Kaloewatoe river valley connecting the village to Manaloe village on the east coast of the island.

FIGURE IV - 52. *Sangihe Island, SW coast, Tamako Bay.* Looking NE toward coast. Tamako village on right. 1939.

(*f*) *Kalinda beach.* (PLAN 18, Section B(f)) Reliability POOR. About 2 miles southeast of the bay of Tamako a small possible landing beach lies at the head of a small cove in front of Kalinda village, 3° 26′ 30″ N, 125° 31′ E. The approach to the beach is clear of dangers except for a fringing coral reef about 800 feet wide which can be crossed at high water in the stream mouths which lie at both ends of the village. The cove is open to the west and south and high seas may be expected with winds from those directions. The beach is composed of a mixture of volcanic and coral sand. The cove is bordered by steep slopes on both sides, and the land behind the beach rises in moderate slopes to a mountain peak 2,500 feet high. The coastal path lies at the foot of the slopes behind the beach.

(*h*) *Bebalang Island beach.* (PLAN 18, Section B(h)) Reliability POOR. The small hilly island, Bebalang, 3° 20′ 30″ N, 125° 34′ E, 430 feet high, with a large tree on its summit, lies about 4½ miles south of Mahoemoe Island. It is believed that a landing can be made at the village on the northern shore of the island where there was a flag pole.

(*i*) *Ngalipaeng beach.* (PLAN 18, Section B(i)) Reliability POOR. A possible landing beach is situated in front of the village Ngalipaeng at the head of the bay of the same name which lies on the south coast of Sangihe Island at 3° 23′ N, 125° 36′ E. The approach to the beach is clear to the seaward edge of a shore bank, least depth 4½ feet, which extends about 600 feet seaward from the beach. Near shore there is a narrow, fringing, coral reef backed by a narrow coral strand. Heavy surf is experienced on the beach except during the north monsoon season. The terrain inland from the beach is steep and hilly. The path leads northward from the village to Saloerang and Manaloe.

(*j*) *Saloerang beach.* (PLAN 18, Section B(j)) Reliability POOR. A small landing beach lies in front of Saloerang village on the southeastern shore of Sangihe Island at 3° 28′ 40″ N, 125° 40′ E. The area is recognized by the hilly islands, Bengdarat and Beng-laoet, which lie 2½ and 4½ miles, respectively, east of the beach. About 1 mile northeast of the latter-named island, there is a group of bare white rocks. The approach to the beach is obstructed by the previously-mentioned islands, but navigable channels exist between the fringing coral reefs which surround them. Shoreward the approach is clear to the wide, fringing, coral reef. High seas and heavy surf are experienced in this area during a north monsoon. A 3-knot current runs through the channel between the island Beng-darat and the beach. The current flows north on the flood and south on the ebb. The water temperature is always greater than 70° F.

The beach is a steep, narrow, coral strand at the inner edge of the reef. Landing on the beach is possible at high water but during the north monsoon it is extremely difficult. The best place to land is at the mouth of the stream which crosses the beach near its southern end. The terrain north and south of the beach is high and rocky but immediately behind it is a flat plain in the center of which there is a hill. Exit from the beach is along the coastal path which trends northwest and southwest from the village.

(*k*) *Manaloe beach.* (PLAN 18, Section B(k)) Reliability POOR. A wide beach about ¾ mile long is situated in front of the village Manaloe on the western shore of the Manaloe Bay, at 3° 31′ N, 125° 38′ E. The area is recognized by the islands of Lebessan, Batoewingkong, and Tehang which surround the entrance to the bay. The approach to the beach lies through the channels among these islands. In the channel southeast of the island Tehang there is a 28½-foot shoal. On the opposite side of the island a detached rock which dries at low water lies off Point Kembono. In addition to these a drying reef lies in the middle of the bay. Shoreward from the reef the approach to the beach is clear. Winds are strongly felt in this area during the north monsoon and create high seas and a heavy surf on the beach. The tides in the bay are both diurnal and semidiurnal, with the latter predominating. The spring highs of the two tides coincide. The maximum rise and fall of the water surface that may be expected is about 4.3 feet above and 3 feet below mean sea level. The water temperature is always greater than 70° F.

The beach is composed of a mixture of volcanic and coral sand. It is firm but its exceedingly flat slope makes the transfer of cargo across the beach extremely difficult. Streams cross the beach near its southeastern end, near the middle, and near its northwestern end. Landings can be made easily on the beach except during the north monsoon. In addition to this beach, landings are possible at the villages on the bay shores of the off-lying islands. Behind the beach there is a broad coastal plain, drained by a number of streams, which extends inland for about 2½ miles and then rises in steep slopes to a range of hills. The main coastal path runs through the village. In addition to this path, a trail trends southwestward to the village Kaloewatoe at the head of the Dagho Bay which is situated on the southwestern shore of Sangihe Island.

(*l*) *Koeloer beach.* (PLAN 18, Section B(l)) Reliability POOR. A small landing beach lies at the head of a cove in front of the village of Koeloer, 3° 33′ N, 125° 35′ 30″ E, which is situated about 2½ miles west of Tehang Island. The approach to the village is clear within the entrance points to the bay, but shoreward the bottom shoals rapidly to the seaward edge of the fringing coral reef which dries and makes landing on the narrow, coral sand beach difficult. High seas and heavy surf which run during the north monsoon are an additional landing hazard. A stream crosses the beach near the southern end of the area. The low coconut-covered plain which lies behind this stretch of coast extends inland for about 2 miles, beyond which the land rises in the steep slopes of Sahendaroeman Mountain. The coastal path which encircles the island runs through the village behind the beach.

(*m*) *Koema Bay beach.* (PLAN 18, Section B(m)) Reliability POOR. About 1½ miles northwestward from Koeloer there is a small beach at the head of Koema Bay, 3° 35′ N, 125° 35′ E. The approach is clear to the fringing coral reef. During the north monsoon a heavy surf breaks on the narrow coral sand beach. A small stream crosses the beach near the northern end of Koema village. An extensive, low, coconut-covered plain extends inland for about 2 miles to the foot of the central highlands. Communication with the adjacent villages is by the coastal path which passes through the village.

(*n*) *Mioeloe Bay beach.* (PLAN 18, Section B(n)) Reliability POOR. On the eastern shore of the narrow center portion of Sangihe Island and at the head of Mioeloe Bay, 3° 35′ N, 125° 33′ E, is a narrow, muddy strand covered with mangroves. The approach to the shore is clear but caution should be used when entering the bay between the fringing coral reefs which line both shores. Landing at the head of the bay, through breaks in the mangroves, is possible but difficult due to the mud and the wide, fringing, coral reef. A small stream crosses the shore a short distance south of the center of the head of the bay.

The best place to land is between the stream mouth and the village Mioeloe. The terrain north and south of the bay is low and covered with coconut palms, but that behind the bay rises in gentle slopes to the range of hills that forms the backbone of the island. Communication with other villages on the east coast is maintained by the main coastal path which passes through the village. In addition to this path, two paths run westward from the northern and southern ends of the area to join the path which crosses the island connecting Manganitoe Bay on the west coast to Peta Bay on the east coast.

(*o*) *Sensong beach.* (PLAN 18, Section B(o)) Reliability POOR. A narrow, coral sand beach lies at the head of a small cove in front of Sensong village 3° 38′ N, 125° 34′ E. Sensong is situated on the northeast coast of Sangihe Island about 1½ miles south of Peta Bay. The approach to the beach is clear to a wide, fringing, coral reef which makes landing hazardous even though the area is well sheltered from winds and waves. The land behind the beach is low and covered with coconut palms.

The coastal path leads through the village to Peta Bay where a trail bears southwestward across the island to Manganitoe Bay.

(*p*) *Peta Bay beach.* (PLAN 18, Section B(p)) Reliability POOR. A small beach and pier lie at the head of the Peta Bay (FIGURE IV - 53), which is situated on the northeast coast of Sangihe Island at 3° 39′ N, 125° 33′ E. The entrance to the bay was marked by a white buoy on the starboard and a black buoy on the port. Two cross beacons, one on the shore and the other on the slope of the hill, formed an entrance range to the harbor. At the head of the bay a light was shown from the pier. The approach to the head of the bay, although narrow between the fringing shore reefs, is clear. On anchoring in the bay, caution should be taken to avoid the sand bank which extends seaward from the fringing coral reef on the southern shore. During the north monsoon strong winds and currents exist in the bay. There is both a diurnal and semidiurnal tide in the bay, but the latter predominates. The spring highs of the 2 tides coincide. The highest water level occurs in May and November. The maximum rise and fall that can be expected are respectively about 4.3 feet above and 3 feet below mean sea level.

The beach is composed of coral sand. A pier lies at its northwestern end and a stream crosses it near its southeastern end. The land behind the beach is low, but a short distance inland it rises gradually to a chain of hills. The coastal path which enters the village from the south widens into a wagon road at the village and leads northwestward along the coast. In addition to the road, a path runs inland across the island from the northwestern end of the beach to Tahoena Bay, while another leads inland from the southeastern end of the beach to Manganitoe Bay.

(*q*) *Northeast coast beaches.* (PLAN 18, Section B(q)) Reliability POOR. Four possible landing beaches lie on the northeastern and northern shores of Sangihe Island between Peta Bay, 3° 39′ N, 125° 33′ E, and Salimar Point, 3° 44′ N, 125° 25′ E. The best landmark for the area is Mount Awoe volcano, elevation 6,102 feet, which stands near the center of the northern end of the island. The approach to this stretch of coast is clear and, although deep water in general lies close to shore, sand banks may be encountered near the stream mouths. During the north monsoon season high seas and heavy surf make landings almost impossible. Tide rips are frequently encountered off the western end of the area. The water temperature is always greater than 70° F.

The beaches are composed mainly of the volcanic sand brought down by the numerous streams which drain this section. The best place to land is on the beach at Taboekanlama near the southeastern end of the section. Here the depths decrease gradually from the 30-foot depth to a narrow fringing coral reef.

The terrain inland from the southeastern end of the section rises gradually toward the interior, but northwestward the slopes become steeper. Near Salimar Point the coast is rocky and the slopes of Mount Awoe are steep. This entire section is served by a wagon road which follows the coast from the Peta Bay to Tariang village on the northwestern tip of Sangihe Island. From near the southeastern end of the section paths run

FIGURE IV - 53. *Sangihe Island, NE coast. Peta Bay.*
Looking N across beaches at head of bay.

southwestward from Kaloerae and Likoepang villages to the Tahoena Bay.

C. Sangihe Islands: Toade Islands.
(PLAN 18)

(1) Offshore.

Off the Toade Islands the waters are clear to the wide fringing reef that surrounds the islands.

(2) Coastal topography.

The islands, Manipa, Boekide, Poa, and Liang, together known as the Toade Islands, lie 4 to 8 miles northeast of Sangihe Island. They are entirely covered with vegetation. Manipa Island has a good wide beach with a gentle slope around the island. Coconut trees are found all along this beach.

Farther northeastward is a group of smaller islets; of these Salehe and Boeang are entirely covered with trees; Bolontahe and Inis are steep rocky masses. They have no beaches. Bolontahe resembles a haystack as it is approached from any direction. It protrudes 164 feet above the sea and has a marker on top of the island, so it is a prominent landmark.

Malihat (Melihang) and Makohat (Mekohahe) are barren rocks, located approximately 18 miles northeastward of Sangihe Island. Both islets are solid table rock which rise 20 to 40 feet above the sea. There is no beach or vegetation on either islet.

(3) Anchorages.

About 550 yards offshore abreast the village of Nipa, located on the south side of the island of Manipa, vessels can anchor in a depth of 44 fathoms when conditions are favorable. From the anchorage the largest house of the village bears 2° and the southeast point of the island bears 61°.

Vessels cannot anchor off the villages on Boekide Island, as the coast reef falls off too steeply. Anchorage may, however, be found 550 yards southeast of the reef, which extends from the southwest point of the island, but the currents are rather strong at this place.

(4) Dangers to navigation.

Between and near the group of islets northeast of the Toade Islands are several reefs and shoals; Bowone Reef, 1½ miles northwest of Boeang, has a least depth of 2¼ fathoms. The drying coastal reef extends 200 yards off.

(5) Landing beaches.

(PLAN 18, Section C(a)) Reliability POOR.

The 2 largest islands, Boekide and Manipa, are populated, and have numerous villages along their shores. The approach to the islands is clear to the wide, fringing, coral reefs which surround them, and landings at high water are possible on the narrow coral strands in front of the villages. The area inland from the beach is hilly and covered with coconut palms and other vegetation. A system of trails connects the villages.

D. Sangihe Islands: Kahakitang Island.
(PLAN 19)

(1) Offshore zone.

The 13 mile passage between Sangihe Island and Kahakitang Island is clear of dangers. The 9-fathom patch, about 4 miles southwest by south of Nenoeng Island, is marked by breakers and tide rips. HO chart 1727 is the best guide for the location of the various islands and the dangers near them.

(2) Coastal topography.

Behongang Bay on the north side of Kahakitang Island extends half way into the island. The entire island, except along scattered sections of the eastern coast, is bordered by a fringing reef.

(3) Anchorages.

Behongang Bay affords sheltered anchorage in 34 fathoms of water in front of the village of Behongang. The extremities of the reefs are easily distinguished. A stone mole with a wooden superstructure has a depth of 6½ feet alongside and is a good landing place for boats.

(4) Dangers to navigation.

The waters around Kahakitang Island are deep. A shoal spot is shown on HO chart 1727 north of the northwestern tip of the island.

(5) Landing beaches.

(a) Behongang Bay beach. (PLAN 19, Section D(a)) Reliability POOR. A landing place for small boats is situated at Behongang village at 3° 11′ N, 125° 31′ E. The approach to the bay is clear and the water is deep close in. Heavy seas are experienced in the bay during the north monsoon. The land behind the beach is low but rises a short distance inland along moderate-to-steep slopes to the hills which almost surround it. Numerous trails lead from the village through the valleys between the hills to villages which lie on the east, south, and west shores of the island.

(b) Other beaches on Kahakitang. (PLAN 19, Section D(b)) Reliability POOR. Landings are believed possible at the villages which exist on the east, south, and west shores of Kahakitang Island. The approach to the landing places is clear to the fringing coral reef which may be crossed by small boats at high water. The beaches, in general, are firm, narrow, and composed of coral sand. The area behind the beaches is in general low.

E. Sangihe Islands: Kalama Island.
(PLAN 19)

(1) Offshore.

Kalama Island is 4 miles northwest of Kahakitang Island and 13 miles southwest of Sangihe Island. The sea around Kalama Island for about 2 miles is clear.

(2) Coastal topography.

Kalama is a circular island, about 3,000 yards in diameter, having a hill in the center 1,190 feet high. There is a fringing coral reef, 110 yards wide, extending from north through west to east along the coast of the island.

(3) Anchorages.

There is anchorage in 33 fathoms about 275 yards offshore abreast the village on the south side of Kalama Island, the village bearing 0°, and the southeastern point of the island bearing 69°. A considerable current has been noticed near the anchorage.

(4) Dangers to navigation.

There are no dangers within 2 miles of Kalama Island.

(5) Landing beaches. (PLAN 19, Section E(a)) Reliability POOR.

Two possible landing beaches are situated in front of the villages on the western and southwestern shores of Kalama Island at 3° 15′ N, 125° 27′ E. The approach to the island is clear to the fringing coral reef which is reported to be about 330 feet in width in front of the village on the southwestern shore. Heavy surf breaks on the beach with strong westerly winds during the north monsoon. A strong current has been noticed off the southwestern beach. The beaches are narrow, firm, and composed of coral sand. Locally, however, rocks may be encountered on the reef, which can be crossed in small boats at high water. The land behind the southwestern beach rises along steep slopes to the main peak of the island, elevation 1,190 feet, while that behind the western beach rises in gentle slopes to the same peak. There are no trails apparent on the island.

F. Sangihe Islands: Para Island.

(PLAN 19)

(1) Offshore zone.

Para Island lies 4 miles south of Kahakitang Island. About 1,000 yards west of the southern tip of Para is located the island of Nitoe. Nitoe Island is about 900 yards long from northwest to southeast and 250 yards wide. The island has a fringing reef along its west and south shores. Salangkere Island and Siha Island lie northwest of Para Island but very close to it. These 2 islands are surrounded by a fringing reef, which at low water joins the islands. There is a strong current between Para and Nitoe Islands and off the southwest point of Para Island. The channel between the islands of Para, Salangkere, and Siha should be navigated only by small native boats. The sea between these 3 islands and Nitoe is deep and clear.

(2) Coastal topography.

Para Island is about 2 miles long, north-south, and about ¾ mile wide. Rocks along the west coast are covered with vegetation and are located north of the inlet in range with the highest point of Salangkere Island and the rocky point south of the village bearing east-southeast. Information regarding trails on the island is lacking.

(3) Anchorages.

There is an anchorage in 38 fathoms nearly 400 yards offshore abreast the village on the southwest point of Para.

(4) Dangers to navigation.

There are no dangers to navigation other than those mentioned under Offshore Zone (Topic 41, F, (1)).

(5) Landing beach. (PLAN 19, Section F(a)) Reliability POOR.

A small possible landing beach lies in a break in the cliffs on the southwest coast of Para Island at 3° 04′ N, 125° 30′ E. Landmarks for the area include the rocks, covered with vegetation, which lie about 1 mile north of the beach; the rocky point south of the beach; and the islet Nitoe which lies about 1,000 yards west-southwest of the beach. The approach to the beach is clear to the fringing coral reef but strong currents may be encountered between the beach and the islet Nitoe. Strong westerly winds during the north monsoon create a heavy surf on the beach. The water temperature is always greater than 70° F. The beach, which can be reached by small boats over the reef at high water, is firm, narrow, and composed of coral sand. The land behind the beach lies on a narrow plain, which is the entrance to a small valley between the 2 hills standing on the southern tip of the island.

G. Sangihe Islands: Mahengetang Island.

(PLAN 19)

(1) Offshore zone and dangers to navigation.

HO Chart 1727 is the best guide for the location of the various islands and the dangers to navigation.

(2) Coastal topography.

Mahengetang Island is situated about 4 miles west-southwest of Kahakitang Island at 3° 09′ N, 125° 27′ E. Mahengetang is a small circular island about 1,000 yards in diameter, which has a peak on the western coast 459 feet high. The island is surrounded by a fringing reef which in places is 2,000 feet wide. Two breaks appear in the fringing reef, one on the east and one on the west coast.

(3) Anchorages.

Suitable anchorage is found near the village on the southwest side of Mahengetang in a depth of 20 fathoms, with the summit of the island bearing 3°, the southwest point 80°, and the road at the village 21°.

(4) Landing beach. (PLAN 19, Section G(a)) Reliability POOR.

A small possible landing beach lies on the southwestern shore of Mahengetang Island in front of the village of the same name. The approach to the village is over a coral bottom and clear to the 30-foot depth which lies about ¾ mile seaward from the beach; however, numerous rocks and an underwater volcano lie a short distance northwest from the area. The 18-foot depth lies from about 600 to 2,000 feet shoreward of the 30-foot depth. Shoreward of the 18-foot depth a rock, which uncovers, lies about 2,500 feet southwest of the flagpole in the village. The fringing coral reef in front of the beach varies in width from about 800 feet to 2,000 feet. Strong westerly winds during the north monsoon create a heavy surf on the reef. Tide rips and eddies have been reported in this general area. The narrow firm beach is composed of coral sand and volcanic debris. The best place to land is in front of the village at the flagpole where the reef is the narrowest. The land behind the beach rises along steep slopes to the hills of the island.

H. Sangihe Islands: Siaoe Island.

(PLAN 19)

(1) Offshore zone.

The channel between the southern end of Siaoe and the hilly Pahepa Island, and other islands to the eastward, is clear and has a least depth of 20 fathoms. The water elsewhere around the island is deep, with depths dropping off abruptly to 10 fathoms close to the fringing reef.

(2) Coastal topography.

Siaoe Island is almost completely mountainous. The coast from Ondong in the west to Hoeloe in the east along the northern coast is steep and rocky. Otherwise the coast is low and surrounded by coral reefs and sand banks. In the north lies the rocky foreland of Point Nameng and in the south the Point

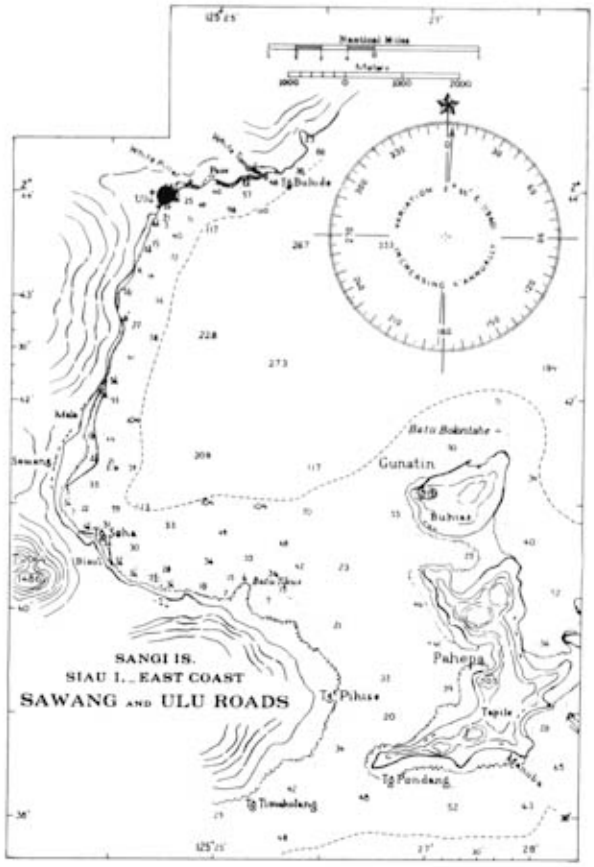

FIGURE IV - 54. *Sangihe Islands. E coast of Siaoe Island. Hoeloe Bay.* Section from HO chart 3061.

Pihise. The only bays worth mentioning are Hoeloe (FIGURES IV - 54 and IV - 55) and Pehe. There are no large plains. The highest peak is Mount Api, which is reported to exceed 5,900 feet. No other peak on the island is higher than 2,300 feet. Near Masio there is a fresh-water lake called Danau Kapeta. The small rivers which exist chiefly in the south part of the island are short and not navigable. The soil is fertile. The island is practically covered with forest. A coastal road, which can be used by carts, extends around the island, except in the most southern part. East of Siaoe lie several islands which are separated from Siaoe by Pondang Strait. The largest of these islands are Pahepa and Goenatin, which are inhabited. Coconut trees, maize, and bananas are cultivated here. The small island of Mahoro is rocky and uninhabited.

(3) Anchorages.

Off Ondong, on the west coast, there is 55 fathoms very close to the fringing reef. Somewhat to the southward, and 220 yards offshore, anchorage will be found in 46 fathoms, with Makalehi bearing 270° and the center of the Ondong village 34°.

Off Talawidtoea village, on the southwest coast of Siaoe, there is anchorage in 44 fathoms, with Makalehi Island bearing 294° and the point to the northward bearing 348°. East of this anchorage the fringing reef extends about 450 yards offshore.

There is anchorage in the channel between the southern end of Siaoe and hilly Pahepa Island. Here is found good holding ground, but the currents may attain a velocity of 2½ knots and eddies may be encountered. Off the village on the west side of Pahepa there is anchorage with shelter during the entire year. Anchorage is not recommended near the islets which lie between Mahoro and Pahepa, as reefs exist and the currents are strong, but between the 3 small islets and Pahepa is a limited area where anchorage is possible.

Off Lia village on the north coast, there is anchorage in 38 fathoms, with the northern point of Siaoe Island, Point Nameng, bearing 311° and the road in the village bearing 216°.

Off Kiawang village on the north coast, there is anchorage in 25 fathoms, with Makalehi Island bearing 254° and the road in the village 133°.

FIGURE IV - 55. *Sangihe Islands. E coast of Siaoe Island. Hoeloe Bay.* Looking NW toward Hoeloe beach and village.

(4) Dangers to navigation.

The shore reefs of Siaoe are well marked by discoloration. A drying reef extends from the north side of Pahepa, connecting it with the steep and rocky Goenatin Island; reefs exist and currents are strong near the islets which lie between Mahoro Island and Pahepa. However, between the 3 small islets and Pahepa there is a limited area where anchorage is possible.

(5) Landing beaches.

(*a*) *Hoeloe beach.* (PLAN 19, Section H(a)) Reliability POOR.

1. Location and extent. A small beach and a wharf lie in front of the village Hoeloe which is situated on the north shore of the bight on the east side of Siaoe Island at 2° 46′ N, 125° 25′ E. The best landmark for the general area is the bare peak of the active volcano, whose elevation exceeds 5,900 feet. The crater of Mount Api lies about 3½ miles north of the village Hoeloe. Local landmarks for the beach include a conspicuous white pillar on the shore a short distance northeast of the village; a flagstaff on the northeast side of the village; and a light which is shown from the government wharf in front of the village.

2. Nearshore. The approach to the beach is clear over a steep sandy bottom to the seaward edge of the fringing coral reef which is about 600 feet wide. North and northeast winds make landings on the beach difficult from January to the middle of April. During the south monsoon, heavy seas break on the reef. The water temperature in this area is always greater than 70° F.

3. Character of beach. The beach which extends along the shore on both sides of the village is composed of a mixture of volcanic and coral sand. It is firm and has a slope of about 1 on 15 to the inner edge of the coral reef which is strewn with debris (FIGURE IV - 56). The beach is interrupted by a wharf which lies in front of the village.

4. Adjacent terrain and exits. Immediately behind the beach there is a narrow coastal plain which rises inland along steep tree-covered slopes to the crest of a ridge of hills. The plain is discontinuous and in places the hill slopes descend to the water's edge (FIGURE IV - 57). Exit from the beach lies along an automobile road which is situated immediately behind it. The road follows the coast southeastward, cuts across the southern tip of the island behind several mountain peaks, and then follows the west coast northward to the village Ondong. From this point the road cuts across the island to the village Hoeloe making a complete circuit of the southern portion of the island. Northeast of Hoeloe the automobile road runs to Kanang village where it narrows to a path which follows the shore around the northern end of the island.

(*b*) *Sawang Bay beaches.* (PLAN 19, Section H(b)) Reliability POOR. Two possible landing beaches, separated by a stretch of cliff, lie at the head of Sawang Bay which is situated about 3½ miles south of the village Hoeloe at 2° 42′ N, 125° 24′ E. The approach to this beach area over a moderately steep sand and stone bottom is clear to the seaward edge of the fringing coral reef which is about 1,500 feet wide in front of Sawang village. North and south of the village the reef narrows to about 400 feet. North and east winds which prevail from January to the middle of March create high seas which break heavily on the fringing reef. The area is well protected during the south monsoon season. The beach, which is composed of volcanic and coral sand, is narrow, firm, and of gentle slope. The best place to land is north and south of the village where the reef is the narrowest. The area inland from the beach consists of a narrow coastal plain which rises inland along the steep tree-covered slopes of Mount Bogangbalo and neighboring peaks farther south. The automobile road which serves the southern part of the island lies immediately behind the beach. In addition to this road a path runs westward from the village to Peling village on the west coast of the island.

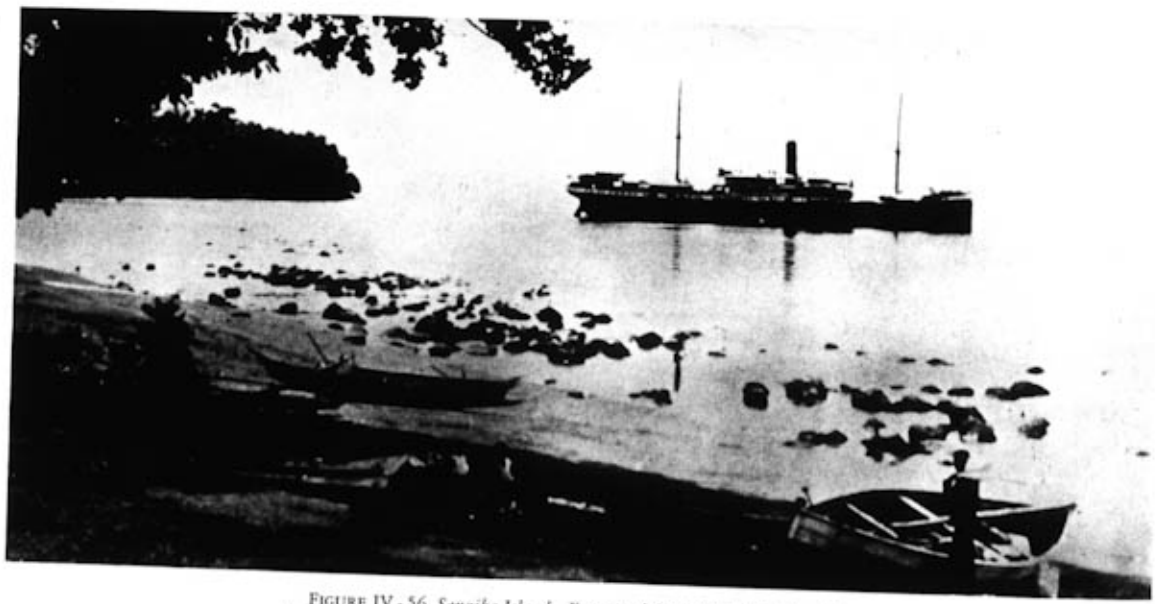

FIGURE IV - 56. *Sangihe Islands. E coast of Siaoe Island, Hoeloe Bay.* Looking N toward northern end of Hoeloe beach and village. 1939.

FIGURE IV - 57. *Sangihe Islands. E coast of Siaoe Island. Hoeloe Bay.* Looking NW toward narrow beach and part of village. Steep hill slopes in rear of houses.

(*c*) *Southwest coast beaches.* (PLAN 19, Section H(c)) Reliability POOR. A sandy beach lies on the southwestern shore of Siaoe Island in front of the villages of Tanaki, Mahoeneni, and Talawide. The beach lies between 2° 39′ N, 125° 23′ E, and 2° 38′ N, 125° 25′ E. The approach to the beach is clear through deep water to the seaward edge of the fringing coral reef which is about 1,400 feet wide. During the south monsoon heavy seas break over the reef and impinge on the firm, narrow, coral and volcanic sand beach. Streams cross the beach at Tanaki and Mahoeneni villages. The area behind the beach consists of a narrow plain which rises in steep tree-covered slopes to the 3 mountain peaks on the southern end of the island. Exit from the beach lies along a path which runs northwestward along the shore and connects to the automobile road at the village of Talawid.

(*d*) *West coast beaches.* (PLAN 19, Section H(d)) Reliability POOR. Possible landing beaches lie in front of the villages Talawidtoea, Lagaeng, Peling, Boembiha, and Paseng, which are situated on the western shore of Siaoe Island between 2° 40′ N, 125° 23′ E, and 2° 44′ N, 125° 22′ E. The approach to this stretch of coast is clear, and deep water extends almost to the edge of the fringing coral reef on which a heavy sea breaks during strong westerly winds, especially during the north monsoon. The beach is a narrow coral sand strand, and is firm. The best place to land appears to be near Peling where the reef is the narrowest. The land behind the beach is in general a narrow plain except near the entrances to the valleys between the mountains, where it widens. Immediately behind the plain and on both sides of the valley the land rises steeply along mountain slopes which are covered with trees. The automobile road which encircles the southern part of the island lies immediately behind the beach. A path crosses the island from Peling village to Sawang village on the east coast.

(*e*) *Ondong beach.* (PLAN 19, Section H(e)) Reliability POOR. A small landing beach lies in front of Ondong village which is situated on the western shore of Siaoe Island at 2° 45′ N, 125° 21′ E. The best landmark for the general area is the bare peak of the active volcano Api, whose crater lies about 3½ miles northeast of the village. There are no dangers seaward from the area and deep water extends almost to the edge of the fringing coral reef, which is about 500 feet wide off the village. Northward and southward from the village the reef widens. Heavy seas break over the reef during strong westerly winds which prevail at intervals during the north monsoon. The beach is narrow, firm, and composed of a mixture of volcanic and coral sand. It is backed by a plain, covered with coconut palms, which lies between steep, heavily-wooded hills to the north, east, and south. Exit from the beach and village lies along the automobile road which runs eastward just north of the village to Hoeloe on the east coast of Siaoe Island.

(*f*) *Pehe—Kiawang segment beaches.* (PLAN 12, Section H(f)) Reliability POOR. A number of possible landing beaches lie between the villages Pehe and Kiawang which are situated on the west coast of Siaoe Island between 2° 45′ N, 125° 22′ E, and 2° 48′ N, 125° 23′ E. This area lies at the foot of the western slope of Mount Api. The approaches to the beaches are clear of danger. During the north monsoon strong westerly winds create a heavy surf along the shore. The beaches are narrow, firm, and composed of volcanic and coral sand. The best place to land is in Pehe Bay at the southern end of the segment, where the automobile road trends eastward to Hoeloe on the eastern shore of the island. Northward from the bay and around the northern end of the island a path follows the coast at the foot of the slopes of the volcano.

(*g*) *Karatoeng beach.* (PLAN 19, Section H(g)) Reliability POOR. Two possible landing beaches lie on the east coast of Siaoe Island from about 2 to 4 miles northeast of the village Hoeloe. The best landmark for the area is the previously mentioned village. The approach to this stretch of coast is clear through deep water over a steep sand bottom. Heavy surf may be expected along this coast from June to the middle of January and during the south monsoon season. The beaches consist of a mixture of coral and volcanic sand, and debris may be encountered on the fringing coral reef. Immediately behind the beach there is a narrow coastal plain which merges inland with the steep slopes of volcanic Mount Api. A small stream cuts across the beach near the northern end of the area. Exit from the beach is by the automobile road which lies immediately behind it at the foot of the steep mountain slopes.

I. Sangihe Islands: Makalehi Island.

(PLAN 19)

Makalehi Island is 12 miles west of Siaoe Island.

(1) Offshore zone and dangers to navigation.

On the southwest side of Makalehi is a small bay formed by a ridge of reefs; it dries at low water.

(2) Coastal topography.

Makalehi Island is 748 feet in height and heavily wooded in some parts. It is almost round instead of being as long and narrow as the chart would indicate. It is higher along the western side than along the eastern. On the southwest side is a small bay formed by a ridge of reefs; it dries at low water. In the center of the island is a small fresh-water lake. The island is inhabited.

(3) Landing beach. (PLAN 19, Section I(a)) Reliability POOR.

A small beach lies in front of the fishing village of Makalehi on the southwest side of Makalehi Island, at 2° 44′ N, 125°

10′ E. The approach to the beach is clear to the fringing coral reef that dries at low water. Strong westerly winds frequently occur during the north monsoon and last from 1 to 4 days. The water temperature is always greater than 70° F. The beach is narrow, firm, and composed of coral sand and debris. Although a heavy surf breaks on the beach during strong westerly winds, at normal times boats can reach the beach over the reef at high water. Fresh water may be obtained from the lake in the old volcano crater on the island. Inland from the beach the village lies in a small natural amphitheater which is formed by the steep slopes of the extinct volcano.

J. Sangihe Islands: Tahoelandang Island. (PLAN 20)

Tahoelandang Island is about 17 miles south of Siaoe Island.

(1) Offshore zone.

A coastal reef extends 1,530 yards from the western extremity of Tahoelandang (FIGURE IV - 58). Another surrounds Pasige Island which lies to the west. The channel between these reefs is deep and clear; the western point of Roeang Island (which lies southwest of Tahoelandang) bearing 180° will lead through this channel when it is difficult to make out the reefs. The channel between Tahoelandang and Roeang Island is obstructed by sunken rocks although there are depths up to 30 feet in places.

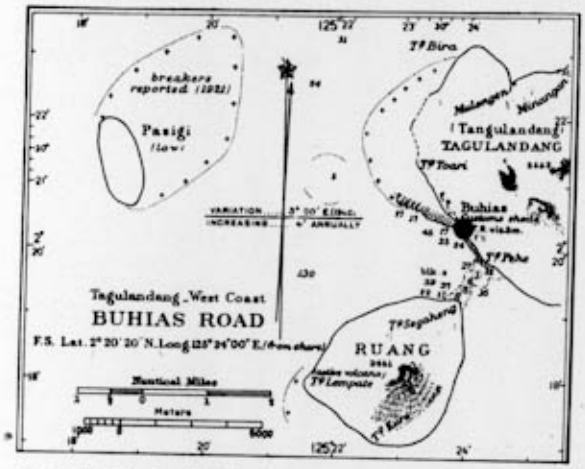

FIGURE IV - 58. *Sangihe Islands. Tahoelandang and Roeang Islands. Boehias Road.*
Section from HO chart 3061.

(2) Coastal topography.

There are landing places on the south coast of the island from Tahoelandang village, known also as Boehias (FIGURE IV - 59) to Kesihan. Probable landing places extend from Likei north to Boelangan on the east coast.

Tahoelandang is mountainous and rises to an elevation of 2,641 feet. Its summit (almost always hidden by clouds) is the highest point of a crater, which is broken on the north-northwest side, forming Minanga Bay. Inside this outer crater is another inactive volcano, 2,592 feet high, which has a round summit and very steep sides. There are 3 warm springs on the beaches; 1 on the north coast and 2 on coast at Boehias village. The springs are located on a line running northeast-southwest approximately through the crater on Roeanga Island and the extinct volcano on Tahoelandang. The south and east coasts are very steep-to. Off the west coast are broad coral bars which are a contrast to the generally steeply rising shores of the islands.

FIGURE IV - 59. *Sangihe Islands. SW coast of Tahoelandang Island.* Looking NE toward coastal village. 1939.

Pasige Island is low, and entirely covered with mangroves. It lies on the southern end of an extensive drying reef which is generally marked by breakers, even at high water.

(3) Anchorages.

Off the village of Haäsi, on the southern side of the island, there is anchorage in 26 fathoms, about 380 yards offshore and 110 yards from the shore reef. From this anchorage the northeast point of Biaro Island bears 181°, the road in the village 13°, and the point to the eastward 83°. It is an open roadstead, and a fairly strong current is experienced at times.

On the north side of the island there is a large bay in which anchorage can be found near the village of Minanga. This bay should be approached cautiously as the depths decrease suddenly and the fringing reef cannot be made out at high water, even when the sea is calm. The fringing reef on this bay is very narrow or entirely absent and ships can approach the shore closely. There are no detached dangers in this spacious bay except for a 2¾-fathom patch about 380 yards from the fringing reef. Anchorage can be found almost anywhere 450 yards from the reefs. The anchorage is well sheltered during the south monsoon and during the period of changing of one monsoon to the other.

(4) Dangers to navigation.

A large coast reef, which is not well marked by discoloration, extends 1,530 yards from the western extremity of Tahoelandang Island.

(5) Landing beaches.

(a) Southern coast beaches. (PLAN 20, Section J(a)) Reliability POOR. An extensive beach interrupted by banks or cliffs lies on the southwestern shore of Tahoelandang Island between the villages Tahoelandang (Boehias), 2° 20′ N, 125° 24′ E, and Kesihan, 2° 19′ N, 125° 25′ E. At the northwestern end of the beach a light was exhibited from a white stone pillar near the flagpole at Tahoelandang village. The approach to the beach from northwest and southeast of Roeang Island and through Roeang Strait is clear to the 30-foot depth, which lies about 600 feet off the seaward edge of the reef, except in the center of the strait where it swings seaward around a shoal, least depth 6 feet. The width of the reef off the beach is irregular. It is very narrow at Tahoelandang village, but southeast-